PAPERS ON METEOROLOGY,

RELATING ESPECIALLY TO

THE CLIMATE OF BRITAIN,

AND TO

THE VARIATIONS OF THE BAROMETER.

By LUKE HOWARD, Esq., F.R.S.

BEING PART I. OF THE APPENDIX TO BAROMETROGRAPHIA.

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APPENDIX TO BAROMETROGRAPHIA.

PART I.

CONTENTS.

RESEARCHES IN METEOROLOGY.

§ I. INFLUENCE OF THE MOON ON THE ATMOSPHERE ACCORDING TO HER CHANGE OF PLACE IN HER ORBIT:—VARIATIONS OF THE BAROMETER, TEMPERATURE, WINDS, AND RAIN IN CONNEXION WITH THE PHASES AND THE APSIDES, RESPECTIVELY.

MR. HOWARD'S first observations on the periodical variation of the Barometer, as connected with the position of the Moon in her orbit, were made while keeping a register of that instrument in the year 1798. This register was kept at Plaistow, in Essex, about five miles east of London, where he then resided and conducted a Laboratory belonging to the firm of Allen and Howard, chemical manufacturers. The course of the Barometer was traced by daily observations on a set of blank charts originally published by Dr. Buxton in the year 1794, each of which served for a month, being ruled horizontally with lines dividing the space into inches and tenths, answering to a scale; and being also ruled perpendicularly with other lines, two-tenths distant, the space between every pair of which was allotted to each day.

As the moon's phases had been inserted in the explanatory plate accompanying Dr. Buxton's charts, by a character affixed to the day, Mr. Howard continued the practice of so indicating them in his register; and being prepared by some previous though slight information on the subject, began, after some time, to observe a coincidence between the phases and the course of the Barometer; which at length became very evident, and gave occasion to further inquiry. This coincidence consisted in the depression of the barometrical line on the approach of the new and full moon, and its elevation on that of the quarters. "In above thirty out of the fifty lunar weeks in this year [1798]," Mr. Howard states in the paper in which he announces these observations, "the barometer will be found to have changed its *general direction* once in each week, in such manner as to be either rising or at its *maximum* for the week preceding and following, about the time of either quarter; and to be either falling or at its *minimum* for the two weeks, about the new and full. It is remarkable that the point of greatest depression during the year, *viz.* to 28·67, is found about twelve hours after the new moon on the 8th of the eleventh month [November]; and

that of its greatest and extraordinary elevation, to 30·89, on the 7th of the second month [February] at the time of the last quarter. Moreover, this coincidence appeared to obtain the most regularly in fair and moderate weather; and, in general, when the barometer fell during the interval between the new or full moon and the quarters, an evident perturbation in the atmosphere accompanied; of which may be instanced II [February] 15 to 23, when the barometer, after an uncommon rise, continued to fall rapidly after the new moon, with severe cold, which ended suddenly in stormy and wet weather; again VI [June] 14 to 20, when two weeks of fair weather ended in a thunder-storm. In the greater part of XII [December] the usual coincidence disappears, and the *converse* takes place; the barometer being low at the quarter and high at the full, amidst continued alternations of rain, frost, and snow; and, for part of the time, high winds. The remarkable depression between the 24th and 28th was attended with intense cold, the thermometer being noted on four successive days at 15°, 14°, 9°, 13°, respectively. On the two days preceding the last quarter, the barometer rose rapidly, and rain followed! In the seventh month [July], which was wet and windy throughout nearly, there is the least of this coincidence to be seen. Instances may be observed in which the tendency to rise or fall at the times pointed out, after being interrupted by an occasional cause, is resumed. On the whole I thought there appeared sufficient ground, on the evidence of the year 1798, to suppose that the gravity of our atmosphere, as indicated by the barometer, may be subject to certain periodical changes, effected by a cause more steady and regular than either change of temperature, currents, or solution and precipitation of water, to which I believe the whole variation has been heretofore attributed. To discover these periodical changes, if possible, and to ascertain their amount independently of the operation of the last-mentioned causes, I took the following method: Passing regularly through the register of the barometer which I had chosen for examination, I extracted one observation for each lunar week, as near as possible to the time of the change, which I ranged under its proper title, either new moon or full, &c. Having gone through the year, I took the mean of the whole of these notations, and afterwards the mean of those under the title of new moon, full moon, first and last quarter, respectively; by comparison of which with the general mean I attained my object."

The Register having been examined in this manner, the results were as follows:

Mean of the Whole.	Full Moon.	Last Quarter.	New Moon.	First Quarter.
29·9638	29·906	30·153	29·719	29·980
Difference . . .	−0·578	+·1892	−·2448	+·0262

"The Register of the Royal Society," continues Mr. Howard, "given in the Philosophical Transactions, affording an opportunity of trying it on a much larger scale, I extracted weekly observations for ten years, *viz.* from 1787 to 96, adhering strictly to the rule I had laid down; and compared the mean of each class with the mean of the whole for ten years, as also with the mean of the register at large for that time, which gave the following results:—

"Mean of the Whole.	New Moon.	First Quarter.	Full Moon.	Last Quarter.
29,818	29,7946	29,8910	29,7812	29,8823
"Difference from the Total Mean . . .	−,0234	+,0730	−,0368	+,0643"

It thus appeared that in the Royal Society's Register "the depressions at the new and full moon either amounted to more, on the whole, than the elevations at the quarters, or that they fell out nearer to the time."

Mr. Howard considered the results which have now been stated to render it "evident that the atmosphere is subject to a periodical change of gravity, whereby the barometer, on a mean of ten years, is depressed at least one-tenth of an inch while the moon is passing from the quarters to the full and new; and elevated, in the same proportion, during the return to the quarter."

He supposed "that the joint attractions of the sun and moon at the new moon, and the attraction of the moon predominating over the sun's weaker attraction at the full, tend to depress the barometer, by taking off from the gravity of the atmosphere, as they produce a high tide in the waters, by taking off from their gravity: and again that the attraction of the moon being diminished by that of the sun at her quarters, this diminution tends to make a high barometer, together with a low tide, by permitting each fluid to press with additional gravity upon the earth."

He next enters upon the consideration of several circumstances attending the facts he had brought forward, which, as he was aware, prevented them from making a case fairly parallel with the tides. "In the atmosphere we have at present no proof of diurnal tides, which ought to be the most apparent. The elevations and depressions of the barometer, *which appear to be periodical*, are sometimes more, sometimes less considerable; but in most cases, when they are regular, greatly exceed the proportion which they ought to bear to the extremes of the scale, on the supposition of their being due to the relative positions of the sun and moon only. They arrive at their extent sometimes before, sometimes after the time of the moon's phases, and their direction is even sometimes contrary to the theory proposed, for many days together; in all which particulars they disagree with the tides of the ocean."

These differences are ascribed to the differing constitutions of the ocean and the atmosphere.

"The want of facts to prove the existence of diurnal tides, appears indeed at first view an insuperable difficulty; since, if these did take place, the barometer ought to indicate them, by rising and falling twice in each day, in a degree proportioned to the supposed weekly tide."

This also is referred to the difference of constitution of the two fluids, water and air.

These views were developed by the author, and the observations upon which they were founded recorded, in an essay "*On a periodical Variation of the Barometer, apparently due to the Influence of the Sun and Moon on the Atmosphere,*" which was read by him before the Askesian Society*, of which he was a member, and published by its permission in the Philosophical Magazine for September 1800 (First Series, vol. vii. p. 355—363). It was accompanied by a chart, entitled "Course of the Barometer for the year 1798," which was a fac-simile of the original register on a reduced scale. A translation of a portion of this essay was inserted by the late Professor Pictet, of Geneva, in his *Bibliothèque Britannique* (*Sciences et Arts*, tom. xix. p. 227; *Mars* 1802).

The author refers, in this essay, to a paper of which a translation had appeared in the Philosophical Magazine for March 1799 (vol. iii. p. 120), giving "*An Account of* Toaldo's *System respecting the Probability of a Change of Weather at the different changes of the Moon.*" With this paper he requests the reader to compare his own observations (written previous to his knowledge of Toaldo's theory), "as they mutually support each other." Toaldo (who was a mathematician of some eminence, and Professor of Physical Geography and Astronomy in the University of Padua,) is stated (p. 126) to have "compared a diary of the state of the barometer, kept for many years, with the situations of the moon, and found the following result: 1st, that the barometer at the time of the moon's apogæum rises the sixth part of a line higher than at the perigæum; 2nd, that at the time of the quadratures it stands a tenth of a line higher than at the time of the syzygies; and 3rd, that it is a fourth of a line higher at the southern lunistice [greatest distance from the zenith] than [at] the northern" lunistice, or nearest approach to the zenith †.

* An account of the Askesian Society will be given in the latter part of this Appendix.

† This result of Toaldo's calculations is cited by M. Arago, in his investigation of the question, "Does the Moon exercise any appreciable influence on our atmosphere?" inserted in the "*Annuaire du Bureau des Longitudes de Paris*" for 1833, as one of those which establish the reality of the moon's action on the atmosphere. With respect to the influence of the apsides, it agrees with the observations subsequently made by Mr. Howard, as stated towards the close of the present Section, page 18.

In October 1801 Mr. Howard communicated to Dr. Tilloch for insertion in the Philosophical Magazine a translation, with which he had been supplied, of a paper "*On the Influence which the Sun has on the State of the Barometer*," by J. J. Hemmer (who was the Secretary of the Meteorological Society of the Palatinate), which had appeared in the Transactions of the Electoral Academy of Sciences at Erfurt, vol. vi. This was published accordingly in the Philosophical Magazine for November 1801 (First Series, vol. xi. p. 151–157). On this paper Mr. Howard remarks, in a prefatory letter, "It is another proof (which I was not possessed of at the time my essay on the same subject appeared) of the attention which this question had obtained on the continent; and as, notwithstanding a considerable similarity in the introductory part, our inquiries appear to have been directed to distinct though closely-connected branches of the subject, each of these papers may prove to the reader a useful commentary on the other."

To a passage in Hemmer's paper (p. 153), relating to observations of the diurnal or horary variations of the barometer made severally by Planer and Chiminello, two members of the Meteorological Society of the Palatinate, Mr. Howard subjoined the following note:

"In examining a twelve-month's Register, kept by — Dunbar, Esq., near the banks of the Missisippi, in N. lat. 31° 28′, and long. 91° 30′ West of Greenwich, which, for the greater facility of comparison, I have laid down, with others, on a scale in the manner I have heretofore exhibited, there occurs a remarkable instance of a diurnal variation. For the space of about four days before, and six days after the summer solstice, the barometer regularly rises from about 9 P.M. to about 6 A.M., then falls till the return of the former hour in the evening, then rises again as before, &c. in alternate periods. In the first four days the direction is *ascending*, and the elevation of a line drawn through the mean is about $\frac{6}{100}$ths of an inch. In the latter six days the mean line is perfectly horizontal, the elevation each night amounting to $\frac{2}{100}$ths, and the depression each day to the same, but occupying double time. The times above given are those at which the observations were made, but it is probable that the maximum and minimum each day corresponded rather with the times of sun-rise and sun-set. The first period of four days was dry, with a temperature of 92° in the middle of the day. This ended in a thunder-storm, on the 21st of the month, with 0·82 inches of rain. The barometer, after this, rose $\frac{4}{100}$ths in the night, then remained mostly stationary, with cloudy weather, until the evening of the 26th [of June, 1800], beginning a second period of six days, during which brisk winds at S., S.E., and S.W., prevailed with rain every afternoon or evening, amounting, in all,

to 1·7 inches. Temperature 85°. The whole occupied just the space between full and new moon; and there are traces of the operation of this periodical influence in other parts of the Register." "I shall not presume at present," Mr. Howard concludes, "to ascribe this variation entirely to planetary influence; but the facts are worthy examination in that respect*."

In the second volume of the "Climate of London," published in 1820, the subject of the influence of the Moon on the Barometer was resumed by the Author, under the head "Of the Lunar Periods."

After noticing summarily the relations of the Rain to the indications of the Barometer, he proceeds, "But furnished only with these general notices, the reader will find himself at a loss to explain many of the movements of the column; to know why it is generally high in severe frost, or with a north-east wind; and why sometimes very low without the expected accompaniment of much rain. He will desire to account for those large sweeps which it makes occasionally, without an obvious regular connexion with the changes of wind or weather; and for its apparent stagnation at other times, about a middle point of elevation †, while the most evident perturbation in the atmosphere is going on, and rain and thunder occur daily. Nor will the sudden depressions attending our southerly gales, and the rapid manner in which the former level is restored after them, escape his inquiry. A clew to the chief of these difficulties is furnished by the fact, now sufficiently ascertained, that the atmosphere is subject, like the *liquid* ocean, to the attractive influence of the Moon's gravity, and from this cause, operating jointly with the Sun's attractive power, it has *its tides and currents*. It was from the supposition of this, not indeed without some ground of observation, that I was induced to cast my Reports on the weather [as originally published] into the form of *Lunar Periods*."

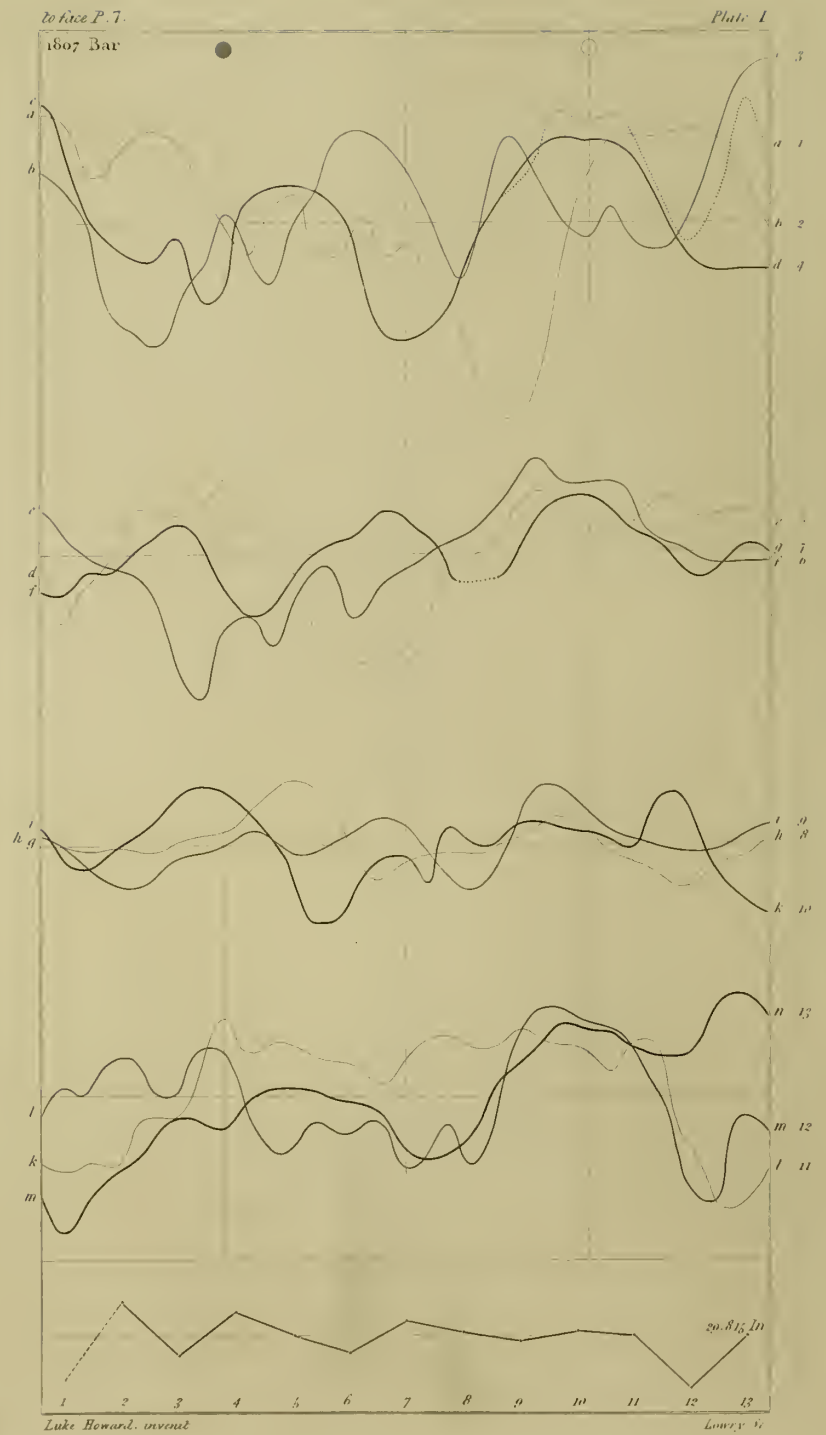
"*Influence of the Moon on the variable pressure of the Atmosphere, on the Temperature, Winds and Rain.*"

"1. By the Moon's change of place in her orbit."

Under this head the substance of the paper "*On a periodical Variation of the Ba-*

* The Register here cited was published in the Transactions of the American Philosophical Society, (Old Series) vol. vi. p. 9, under the title of "Meteorological Observations, for one entire year. *Made by William Dunbar, Esq., at the Forest four and a half miles east of the river Mississippi in North Lat.*" etc.

† This small oscillation about a middle point, Mr. Howard has since satisfied himself, is owing to the presence and occasional mixture of two currents, northerly and southerly, between the forces of which the barometer is balanced.



Luke Howard. invenit Lowry Sc

rometer, etc.," published in the *Philosophical Magazine*, as already stated, is first given, followed by these remarks:—

"Such was the state of my information on this subject twenty years ago (or in 1799). The study of the modifications of clouds, and the various phænomena connected with them, afterwards occupying my attention, this particular enquiry was suspended: and when, in 1806, I began to keep a regular Meteorological Journal, it was with more general views. But being still desirous of putting to the test the opinion of a Lunar tide in the Atmosphere, I was induced, as already mentioned, to digest the observations in the form which seemed to afford the greatest facility for this purpose. It remains to show how far the purpose was fulfilled.

"Plate I. exhibits, in a system of curves, the variation of the *daily mean height* of the Barometer through the *Solar year* 1806–7."

They are constructed from observations of the Barometer, stated in inches and hundredths, in Tables II. to XIV. inclusive, of the "Climate of London," which are part of those Mr. Howard first published monthly in the magazine entitled the Athenæum*. The periods, however, are differently arranged. In the Tables they begin at the New Moon; but for the curves, in order to show more evidently the influence of New and Full Moon, the periods are "made to begin with the day of the third quarter; which happens in this instance to be the first day of 1807. After a dotted curve, therefore, giving the variation from Dec. 22, 1806 to the end of that year, the several curves *a*—*b*, *b*—*c*, &c. carry on a series of entire Lunar periods to the 21st of Dec. 1807, at *n*, where the Solar year closes."

These curves were constructed in the following manner: the *mean of the period* was ascertained by calculation, and represented by a horizontal line. The relation of the *mean of each day* to this standard line was next ascertained and marked; and a curve carried through the points thus found, represented the variation, at its proper extent, above and below the standard. In doing this the mean of the day on which a Lunar phase happened, was made always to fall in the intersection of the curve with a perpendicular line appropriated to that phase. Some inequalities of time in the intermediate parts of the curve, occasioned by this arrangement, were remedied, where needful, by using an unequal scale of time in those parts.

"By this method [in concert with the late Silvanus Bevan, Jun.] the curves were all obtained of an equal length, and presenting equably the relation of the Lunar points to the Barometrical mean for the period. Their tendency to rise and fall at particular intervals, and their consent or opposition in such movements, was thus also repre-

* An account of the original publication of Mr. Howard's Meteorological Observations will be given in a future Section.

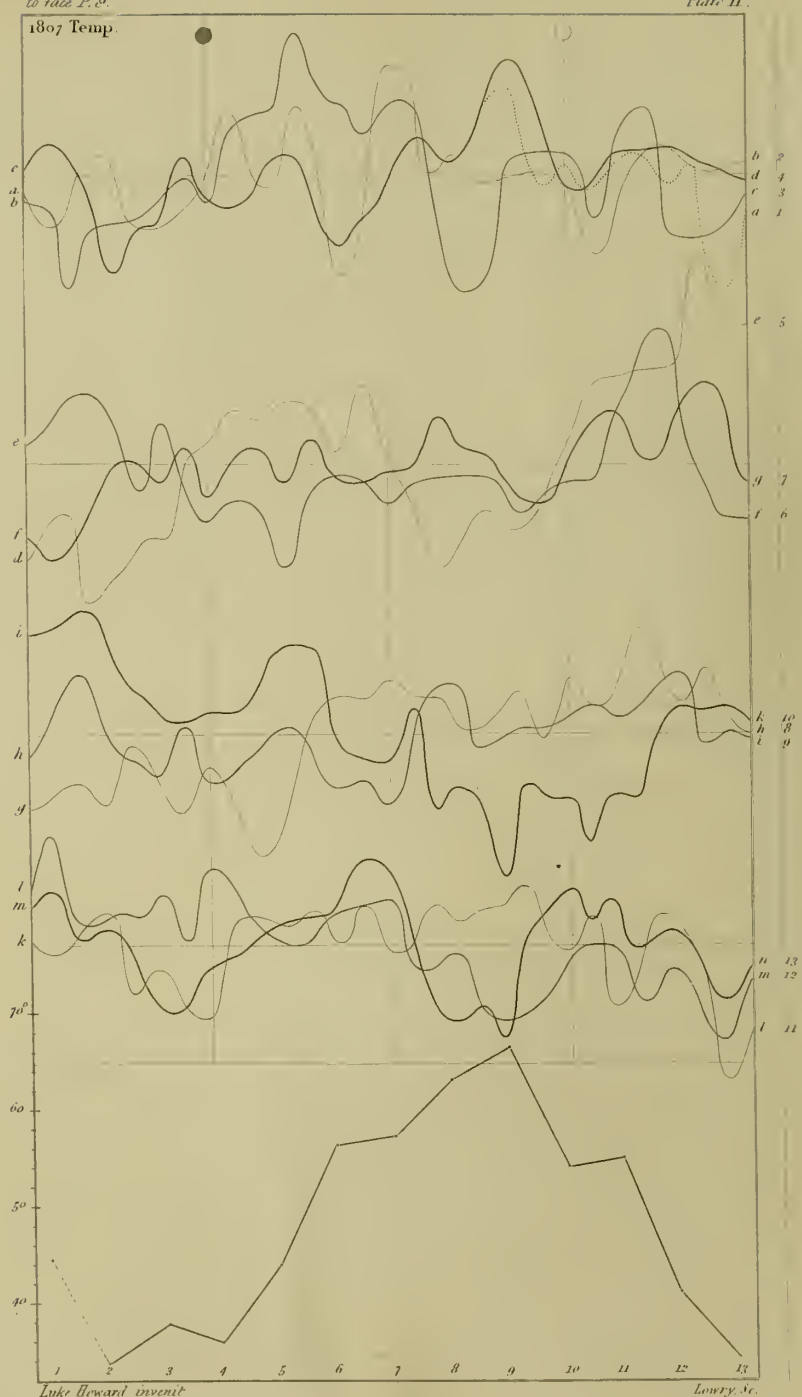
sented *independently of the absolute place of the mean of the period, or of that of each day, in the Barometrical scale.* Each of the four horizontal lines, on which the curves are made to play, has therefore an elevation peculiar to itself, and relative only to the curves in connexion with which it is viewed: its *absolute* place in the scale of the Barometer may be gathered from the small curve at the bottom of the diagram; where these monthly means are laid down upon the mean of this Solar year, which is 29·815 inches.

"All this contrivance was needful in order to exhibit the distinct effect of each Lunar position, unmixed with that kind of variation, from month to month, in the mean of the Barometer, which depends on the season of the year.

"To proceed now to the application—it is difficult not to be struck at first sight with the evident marks of *system*, which these curves exhibit, from the beginning to the end of the series.... The most prominent feature of the piece may be said to be, the nearly constant *elevation of the curve* at the approach of *Full Moon*—a very contrary result, certainly, to that found in the year 1798, and sufficient, at first view, to invalidate the partial conclusion I then came to, that the true atmospherical tide consisted, in part, of large depressions under this quarter. These elevations, however, will be found to have their *apex*, for the most part, about two days before the full, and to be going off at the time of the phase. That they are properly connected with its approach, may be fairly inferred, from the manner in which the curve No. 2 rises at this time from a great depression, as if prevented from taking an upward tendency by some unusual cause, and become more elastic by being thus strongly bent downward.

"If we now turn to the *New Moon*, on the left of the Plate, we perceive its approach marked, by depressions chiefly in the fore part of the year, and by elevations in the latter part. Yet the actual time of this position, or rather a day or two after it, exhibits a strong tendency in the diurnal variation to return to the mean of the period: and the same observation applies to both the other *quarters*; which have also some peculiar *opposite* variations connected with them. The latter are conspicuous in the elevations which belong to the *third quarter* of the first three periods, and in the depressions which attach to it in the last three: each however with an exception attached: see Nos. 4 and 13.

"Enough has perhaps been pointed out, to satisfy the reader that in this year, there was a decided connexion between the Lunar positions, and the mean daily movements of the Barometer; which deviated in the same direction about the same point of a Lunar revolution, whether the mean of the season occupied the higher, lower, or middle part of the scale.



Luke Howard invenit Lowry Sc.

"Very early in the course of these inquiries I perceived, on tracing the curve of the diurnal mean Temperature, on the same scale and referable to the same mean line with that of the Barometer, that the connexion was almost constant between them. It is manifested in two different ways, which may be termed conjunction and opposition; since in the one, the curve of the mean temperature accompanies (or precedes or follows by a short interval) that of the Barometer, and in the other the two vary in opposite directions, often with a very near coincidence in time. See Fig. 1, in the next page.

"Two degrees of Fahrenheit are equivalent in these variations to a tenth of an inch in the Barometer. Such are the proportions observed in this figure, the parts of which are copied from some of the many periods I have traced in this way. When the two curves run in opposition through a period, they cross at intervals and form a succession of rhombs, differing in magnitude according to the extent of the variation in either or both of the curves: when the two run in conjunction, the resemblance in the number and extent of the changes is often so close that the one might easily be mistaken for the other. There are also many periods in which both the kinds of relation appear; and some in which neither is very obvious.

"In Plate II., the variations of the *daily mean temperature* through the Solar year 1806–7 are traced in curves, bearing the proportion already mentioned to those of the Barometer, and constructed, in other respects, on precisely the same plan as in Plate I.

"The place of the *mean line of each period* in the Thermometrical Scale, is indicated in the curve at the bottom of the Plate.

"These curves present features in some respects less striking than those of the Barometrical variation; but which, when attentively examined, indicate equally the existence of a system of variations, governed by the Moon's attraction, as a secondary cause, subject on the whole of the year, to the more powerful influence of the Sun as he varies in declination.

"The greater variations of temperature, it may be first remarked, appear for the most part during this year in the intervals of the lunar phases: and there is a tendency in the curves to approach about the time of the phases to the mean line, commonly in order to cross it, and assume an opposite deviation; from which they often return within the week, as before. The change of the mean of the period, again, from a lower to a higher place in the scale, or *vice versâ*, according to the season, is effected not so much by the gradual elevation or depression of the Temperature through the period, as by sudden bold sweeps of the curve in particular parts of it."

Instances in Plate II. are then cited, in which "the curve assumes a decided tendency upward or downward, two or three days before the Full Moon, which it preserves through the following week, the warm or cold weather coming in with this movement;" and others which present almost equally bold upward "sweeps, having their *nodes* (if I may be allowed so to use the term) about New Moon; but these elevations do not hold their level afterwards."

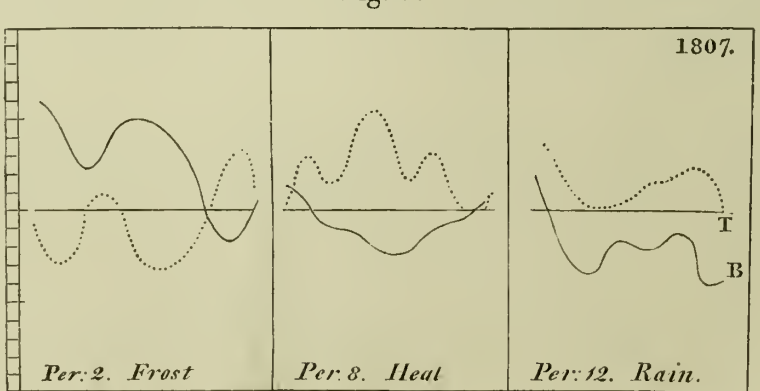
Three cold periods are next cited, which "if we contemplate," the author observes, "in connexion, their general character, notwithstanding a large depression in each, about the middle, will appear to be that of a rising Temperature by the influence of the *New*, and a falling one by that of *Full* Moon."

In certain periods, also exhibited in Plate II. "of increasing Temperature, the near agreement in the time of beginning their most considerable elevations above the mean will scarcely be thought accidental." One of them has "in effect five points of intersection with the line; which limit four distinct and contrary oscillations of Temperature, each performed in the space between two Lunar phases."

"Lastly, in . . . . three periods of descending Temperature, ... there are six or seven depressions nearly coincident with each other in time. . . . . the curve of the mean Temperature (like that of the Barometer) sometimes proceeds in gradually increasing and decreasing oscillations, about a general level or line of direction, which it has assumed for a few days." Examples of this are then referred to.

"The Barometrical variation will be found, on comparing together the two systems of curves, to be mostly in opposition to, but at times in conjunction with, the Temperature. In the early cold periods, and in the fine weather of summer, *opposition* will be found predominant; but in the decline of the year, when the atmosphere is losing both heat and water, the two curves often vary in the same direction.

Fig. 1.



"Figure 1 contains specimens of Barometrical and Thermometrical curves in each state of relation. In the first pair, the season being frosty (the time, the first ten days of 1807), the Barometer ranges high, yet descends a little, to meet an elevation of the Temperature above the mean of the period, in the first week. After this, with a south wind, the two curves suddenly change places, marking an intermission of short continuance in the frost.

"In dry hot weather we have the reverse of this arrangement; the Temperature forming oscillations above the mean, and the Barometer an opposite curve below it. Such is the character of the variation for the space of eight days following the 18th of July, chiefly included in period 8, and represented by the second pair.

"The third pair is a specimen of the agreement in direction of the two curves, when the season is tending to rain. Here we have the Temperature above the mean, but descending; and the Barometer below it, descending also: a slight opposite movement being felt, at the same time, by both instruments. This specimen is a part of Period 12, beginning the 1st of November; and it is by no means the most interesting example which my set of curves, as far as already made out, would present. This week furnished about an inch of water, to the rain-gauge at forty-three feet elevation.

"We have next to enquire into the connexion of these variations with the changes of wind, and distribution of rain in each period; which will be found strikingly unequal, and quite as much influenced in this year by the Moon's position, as the variation of the Barometer.

"I shall first put down the rain for this Solar year, in a form calculated to show its relation both to the phases and periods. In dividing it, the day of the *phase* was considered as the *middle point* of a *week's* rain; and where any quantity fell on a day equidistant between two phases, it was referred to that with the lowest Barometer."

A tabular view is then given, showing the inches of rain for each period (13 in number,) from last Qr. to last Qr. of the Moon. The amount of rain at the ground was for the New Moon 5·09, First Qr. 6·17, Full Moon 0·84, Last Qr. 6·92 inches: the total for the Solar year is 19·02 inches.

"The great and almost positive *dryness* of the *Full Moon week* during this year, is thus rendered equally conspicuous with the elevations of the Barometrical curve by which it was accompanied." See Plate I.

"The immediate cause of both will presently be shewn to be, *the prevalence of Northerly winds during this part of the Lunar revolution.*

"A space of eight days being taken out of each period, for the New and Full Moon respectively, with the phase as nearly as could be in the middle of the time, the daily observations on the wind were found to number as follows:

"Winds.	New M.	Full M.
N. and N.E.	13	20
N.W.	7	21
West	19	15
S.W.	33	17
S. and S.E.	6	4
East	5	11
Totals	83	88

"The North-west, which has been already shown to be our fair weather wind, appears here thrice under the aspect of the Full, for once under that of *New* Moon: and the North and North-east are more frequent in the former, in the proportion of 3 to 2.

"On the other hand, the New Moon, which exhibits so many depressions of the curve, has about double the number of South-west, and a proportion of 3 to 2 of South-east winds, compared with the Full.

"The West wind predominates here in the division allotted to the New; and the East, to more than double, in that of the Full Moon. I do not consider this disparity as so much connected with wet and dry as the former between the Northerly and Southerly winds. But so far as it is concerned, the *East* wind appears to have been productive rather of *rain*, as will appear by the following statement, in which a week's observations are taken out, for each quarter, with the phase in the midst.

"Winds.	First Qr.	Third Qr.
N. and N.E.	8	21
N.W.	9	6
West	20	10
S.W.	26	13
S. and S.E.	2	8
East	0	9
Totals	65	67

"Here the Third quarter, which is the wettest phase, has thrice the amount of Easterly winds that appears in the First; and only half as much South-west. But

in a very dry year it is not so easy to decide from what quarter we receive the rains, as when the cases of heavy rain are multiplied.

"On the whole of this year, a connexion between considerable depressions of the Barometer and the more copious rains is sufficiently apparent; although there are large depressions attended with but little rain. For the former, see periods 3, 6, 10, 11, 12, 13: and for the latter, 2, 5. In periods 3, 4, 7 and 9, there are examples of rain connected with a mean height of the Barometer, and a mean Temperature for the season.

"The influence of the Moon on the Temperature and density of our local atmosphere, appears therefore, with respect to these more obvious and frequent changes, to be exercised chiefly through the medium of the winds. It is a secondary effect of her varied attraction, which continually tends to change the bearings of the different currents in motion in the great body of the atmosphere; and we are thus successively involved in all their modifications. Not but that there are seasons in which the predominant Solar influence is exerted to a degree, which renders these Lunar changes of small consequence: and when in spite of the various aspects of our attendant Planet, we are drenched with rain or parched with drought, for months together."

"The variation of 1807, like that of 1798, appears to be in great measure peculiar to the year in which it is found, and it gives place in the succeeding years to a different set of combinations.

"The elevations of the *Barometer* about the Full Moon, for instance, which appear in 1807, are found in much less proportion in the next year; and in 1809 they mostly yield to depressions in the same place; the New Moon acquiring in the mean time longer and more numerous elevations.

"With regard to *Temperature,* again, the different positions afford different results as the years proceed. In 1807, the average of the mean Temperature taken upon each day through the twelve periods, exhibits a very regular appearance. The Temperature thus obtained being laid down in a curve upon the mean of the whole, it is found to descend below the mean line, in the intervals between Last Quarter and New Moon, and First Quarter and Full Moon respectively, the depressions being carried a little beyond the latter phases: it then rises more abruptly than it fell, and the elevations thus formed in the alternate intervals go off before the arrival of the Quarters. But in the two following years, the parts occupied by these elevations were found by the same method to be passing off into depressions, and those before occupied by depressions first rising to the mean line, and then becoming elevations.

"The mean Temperature of these respective intervals for 1807, taken at equal distances and with a clear day allowed after each phase, were found as follows:

"Mean Temp. from Last Quarter to New Moon . . 47·04°
New Moon to First Quarter . . 49·66°
First Quarter to Full Moon . . 47·67°
Full Moon to Last Quarter . . 49·78°

"The *proportions*, only, of the rise and fall would have been somewhat different, had the Temperature been taken strictly from phase to phase. The Temperature of our atmosphere during this year was therefore alternately elevated and depressed to the amount of at least *two degrees* in each Lunar week, by some cause connected with the Moon's positions: which yet did not operate precisely in the same way in the following year. Indeed the curve of the Lunar mean Temperature for 1809, obtained in the manner before mentioned, is in its general appearance a contrast to that of 1807.

"The Full Moon week also loses in 1808, its *dry* character; which is not immediately taken up by another phase: it exhibits in this year about four inches of rain; and rather more in 1809. The *wet* phase in 1808 is the First Quarter; and it is so again, though with a smaller excess over the other quarters, in 1809: the Last Quarter becomes drier in proportion.

"A great depression of the Barometer appears in 1807, in the period No. 2, which goes off with a remarkable upward sweep of the curve, about the time of Full Moon. There are nearly parallel depressions, equally conspicuous, in the two following years. In 1808, the sudden rise after the crisis occurs 20 days earlier in the year, and with a like relation to the first Quarter: in 1809 it is about 20 days later, and attached in like manner to the time of New Moon. It is remarkable that in each case the full pressure was restored chiefly by means of *South-west* winds, and without any excess of rain, or storm of wind. Such periodical large movements, and in the backward order of the phases in this instance, deserve notice; as being probably connected with extensive changes in our Northern atmosphere; perhaps with the shifting, through several degrees of longitude and latitude, of the range of the larger currents, which depend on the Sun's progress in North or South declination."

By a corresponding method of investigation, Mr. Howard arrived at the conclusion "*that the Lunar positions, however they may affect the distribution of the rain, produce no sensible difference in that of the evaporation.*

"This process is nearly a continuous one through the year: it is an effect of the temperature of the water, modified by the greater or less velocity of the wind agitating its surface [and by the vapour already present in the air]. But *rain* is an occasional

process; and appears to require a more complex arrangement of causes, at least for its prevalence in a given district. We have here to take into account the Temperature and Electricity, absolute and relative, of both the earth and atmosphere; the relative temperature, moisture, and perhaps electricity of different simultaneous currents [in the latter]; the direction of these with regard to neighbouring seas and continents, and to the slope or exposure of the district itself; and lastly, as it seems, the Moon's influence."

The preceding view of the influence of the Moon on the atmosphere, according to her change of place in revolution, is given in the first edition of the "Climate of London," vol. ii. from p. 221 to p. 243. When discussing, in the same work, her influence according to her place in North or South declination, the author returns to the present subject for the purpose of showing that the effects which he attributes to each cause respectively are in reality distinct. This will be noticed in the next Section.

In 1821, Mr. Howard communicated to the Royal Society "A Meteorological Report for the year 1820 in the vicinity of London"; which was read before the Society on the 10th of May, and is printed in the second part of this work, page 1[a].

In this paper, after referring to the "Climate of London" as lately published, and to the discussion of the periodical variation of the weather contained in it, the author observes that the lunar influence is as well marked in 1820 as in either of the two years, (1807 and 1816,) which he had before investigated; but that being an average year, both in rain and temperature, it differs from them in some important particulars. The period examined comprehends, in 355 days, twelve lunar revolutions, beginning at the moon's first quarter, and thirteen periods of declination.

After exhibiting and discussing the influence of the moon in declination, he infers, from investigating the rain as subject to it, that the moon's influence by her position in her orbit, must always be considered along with the former. This inference he proceeds to examine, and finds reason to presume that in the summer of 1820, when the effect of declination was least sensible, that of the phase operated in its place. This is verified by averaging the rain for each phase throughout the thirteen periods of declination; by which it is shown also that the space in the lunar revolution from the *First Quarter to the Full Moon*, or the approach to the opposition, decided in this year the tendency to copious rains; and that the space between the *Last Quarter and New Moon*, or the approach to the conjunction, brought the dry weather; while the two intervening spaces had each a mean quantity of rain; which may be considered

as a proof, it is remarked, that the moon in these parts of her orbit had no decided influence on the rain. The reader is then enabled to pursue for himself the examination into the effect of the phases on the barometer and thermometer, by means of a plate of thirteen curves (Plate I[a].), representing the variation of the barometer for the thirteen periods, (traced from those recorded by the clock-barometer described in the introduction to the present work,) and of a tabular view of the mean temperature, mean pressure, rain and winds for each section of the curves. The signs for the lunar phases are attached to the curves in the days on which they occur. The paper concludes, so far as the subject now before us is concerned, by pointing out that the moon's position, or course in her orbit, may in some seasons coincide with, and in others counteract the effect of declination.

In the second edition of the "Climate of London," published in 1833, the subject remains as in the first edition; (with slight verbal alterations here adopted;) but is discussed under the head "*Of Periodical Variations*," vol. i. from p. 154 to p. 172.

The conclusions arrived at in the paper published in the Philosophical Magazine, and in the Climate of London respectively, relative to the influence upon the Barometer of the Moon's position in her orbit, were summarily stated in Mr. Howard's "Seven Lectures on Meteorology," published at Pontefract in 1837, but the substance of which had first been delivered at Tottenham to a select circle of friends in 1817, and "repeated on different occasions and to like companies" during the interval. The statement is made in the Fourth Lecture, p. 69, and p. 79–82.

On the 12th of March 1840, another paper by Mr. Howard was read before the Royal Society, entitled "On certain variations of the mean height of the Barometer, mean temperature and depth of Rain, connected with the Lunar Phases, in the cycle of years from 1815 to 1823." Of this paper (which is printed at length in the present volume, page 19[a]) the following abstract was given in the Proceedings of the Society, vol. iv. p. 211.

"The table given in this paper [the author's purpose in which, it may be added, was to show what might be done by such an examination as that to which he had submitted the very dry year 1807 and the very wet year 1816, extended through a period of nine years] contains the results of calculations relating to the objects specified in the title; cast into periods of six, seven, or eight days, so as to bring the day of the lunar phase belonging to it into the middle of the time. The observations were all made in the neighbourhood of London. It appears from them that in the period of the last quarter of the moon the barometer is highest, the temperature a little above the mean, and the depth of rain the smallest. In the period

of the new moon, both the barometer and temperature are considerably depressed, and the rain increased in quantity. The influence of the first quarter shows itself by the further depression of the barometer; but the temperature rises almost to the point from which it had fallen, and the rain still increases, but not in an equal ratio. Lastly, the full moon again reduces the temperature; while 'with the barometrical average at its minimum*' the quantity of rain is the greatest. Thus it appears, that during this lunar cycle, the approach of the last quarter is the signal for the clearing up of the air, and the return of sunshine."

A second edition of Mr. Howard's Lectures on Meteorology, "carefully revised by the author," was published at London in 1843, in which the summary statements relative to the influence of the Moon on the Barometer were repeated, exactly as they had been made in the first edition.

VARIATIONS OF THE BAROMETER, ETC. IN CONNEXION WITH THE LUNAR APSIDES.

In the "Climate of London," after concluding the discussion of the observations and averages from which he infers the varying action of the Moon upon the weather according to her place in declination, (as given in the ensuing Section of the present work,) and before proceeding to state his views on the theory of the winds,—arising from those he had been led to form on the extent and definite termination of the atmosphere and on the distribution of heat within it, as affected by the consideration of the Moon's attraction,—Mr. Howard adverts to the connexion of the Lunar Apsides with the variations of the Barometer, in the following terms:—

"I might add to the mass of evidence on this subject some proofs of a peculiar relation between the Moon's *apogee* and *perigee*, and the mean height of the Barometer on the days on which they occur: but I have nothing as yet, so far digested as to be relied on."—First Edition, vol. ii. p. 270; Second Edition, vol. i. p. 197.

* In this abstract, as given in the Proceedings of the Royal Society, we have "while the barometer attains its *maximum* mean height," which is erroneous. The effect of the full moon, as shown by the calculations (page 21[a]) and as stated in the original paper (page 23[a]), is to depress the barometer. The abstract is here corrected by the substitution of the words of the paper itself.

The proofs alluded to in this passage had been obtained by the Author, in pursuing the inquiry relative to the influence of the Moon, into the possible connexion of the barometric variation with the lunar apsides, by the examination of three years of his own observations with the Clock-Barometer, and two years of former observations with the same instrument by its constructor, Mr. Cumming. Mr. Howard afterwards extended the inquiry to the cycle of nine years, from 1815 to 1823, for which, as we have seen, he had previously investigated the connexion between the Lunar Phases and the variation of the Barometer, etc., and made it include the concomitant phænomena of temperature, winds and rain, as in the preceding investigation.

In 1840, he communicated a paper on the subject to the Royal Society, which was read on the 14th of May, entitled, "Tables of the Variation, through a Cycle of Nine Years, of the mean Height of the Barometer, mean Temperature and Depth of Rain, as connected with the prevailing Winds, influenced in their direction by the occurrence of the Lunar Apsides; with some concluding observations on the result."

This paper is inserted in the present volume, page 23[a]: an abstract of it appeared in the Proceedings of the Royal Society, vol. iv. p. 226, of which a corrected copy is subjoined.

"From the Tables here given, the author draws the following conclusions:—

"1. The barometer is higher under the lunar apogee, than under the perigee*; the mean height in the former case being 29·84517, and in the latter 29·75542.

"2. The mean temperature is lower under the apogee than under the perigee; that of the former being 48·3885°, and of the latter 49·0356°. The mean of the whole cycle is 48·7126°.

"3. The rain of the weeks following the apsis exceeds under the perigee; but with two striking exceptions in the annual result on nine years, the one in the wettest, and the other in the driest year of the cycle.

"With regard to the winds, the author remarks that those from the north, north-east, and east, prevailed under the apogee on 38 days, under the perigee on 21 days; and those from the south, south-west, and west, prevailed under the apogee on 20 days, under the perigee on 38 days.

"It appears, therefore, that in the climate of London, the Moon in her perigee brings over us the southern atmosphere, which tends to lower the density and raise the temperature of the air, occasioning also a larger precipitation of rain. In

* See page 4.

the apogee, on the contrary, there is a freer influx of air from the northward, a higher barometer, a lower temperature, and less rain; subject, however, to a large addition of rain under this apsis twice in a cycle of nine years, at the times when also the extremes of wet and dry take place upon the whole account of the year* ".

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§ II. INFLUENCE OF THE MOON ON THE ATMOSPHERE ACCORDING TO HER CHANGES IN DECLINATION.

This subject was originally discussed by Mr. Howard in the first edition of the " Climate of London," vol. ii. p. 243 to p. 277; being introduced by the following statement:—

" The inquiry into this part of the subject was first proposed to me by Silvanus Bevan, junior, of London, lately deceased [1819]. What I shall offer upon it is principally derived from his minute and accurate examination of the data furnished by my Register. Other parts of the work had been before improved by his assistance; and the diagrams were nearly all finally prepared by his hand for the engraver.

" The object of this inquiry, which my deceased friend had left imperfect, may be thus stated. Since it is evident that the Moon exerts an influence, through the medium of the winds if not also directly, on the atmosphere of these latitudes, the effects ought to be felt in a greater degree when that planet, by acquiring her highest North declination, becomes at her Meridian altitude almost vertical to us, than when, being South of the Equator, she is vertical to a distant latitude in the other hemisphere. To ascertain this, it was necessary to submit some part of the observations, in my first volume, to the like test as in the case of the Lunar phases; by comparing, in detail, particular results with a general average. The years 1807 and 1816, the one the driest, the other the wettest of a series of 18 years, were selected as first entitled

* In the Proceedings of the Royal Society, the mean temperature for the entire cycle is substituted for that under the apogee, and the former is stated to be that " of the whole year." In the conclusion respecting the rain, the word " that" is inserted, leading the reader to suppose that " apsis " is erroneously substituted for " apogee;" and in the last line of the abstract, we have " amount" instead of " account." These errors render the alleged conclusions of the author almost unintelligible; they are not corrected in the *errata* of the volume of the Proceedings which contains the abstract.

to notice; and the results have proved of greater value than either of us had anticipated. It is evident, from these two years alone, that not only the variable pressure of our atmosphere, but its mean temperature likewise, and the periods of the deposition of rain, are modified by the Moon's declination. Thus, another important feature is added to this already complex subject: and the same anomaly, arising from the combination of different causes producing the phænomena, is found here also—that particular results appear in opposition to a general rule; which rule is yet in the end satisfactorily established by general averages."

Two tables of averages are then given; the first, (p. 245) of "*Barometrical Averages, in Half-periods of Lunar declination*: from 29–30 Dec. 1806 to 20 Dec. 1807, or 355½ days: Mean of the whole 29·816 inches."

The second table (p. 246–247) gives "*Averages of the Barometer and Thermometer in Quarter-periods of Lunar declination*, from the 3rd of 1st Mo. (Jan.) to the 23rd of 12th Mo. (Dec.) 1807, or 355 days. Mean Temperature 48·58°. Mean of the Barometer 29·814 in."

These averages Mr. Howard proceeds to discuss, stating their results in the following manner.

"In *ten* out of thirteen cases, the Barometer averaged above the mean, while the Moon was in South declination; and below it, while she was in North declination: *three* exceptions appear, which belong to the *winter*.

"The total results are these,

"On 177½ days with the Moon South	29·857 in.
On 178 days with the Moon North	29·775
Mean of the 355½ days	29·816
Elevation for her position South of the Equator .	·041
Depression for her position North	·041

"A similar calculation of averages having been made for 356 days, from the 24th of 12th Mo. (Dec.) 1815, to the 13th of the same, 1816, but without descending to half-days in dividing the periods, the results are as follows:

"On 180 days, Moon South	29·765 in.
On 176 days, Moon North	29·704
Mean of the 356 days	29·735
Elevation for her position South	·030
Depression for her position North . . .	·031

"The Barometer having stood lower and ranged less in this year than in 1807,

the variation for declination is less in amount accordingly. The cases which appear against the general rule, or in which the Barometer averages *higher* under a *North* declination, form in this year a majority, occurring in seven out of thirteen periods; and of these seven, *five* clearly belong to the *summer* half-year.

" In the Table, page 246–7, the mean Temperature is taken along with the mean heights of the Barometer for 1807, and each period is divided into *quarters*. The intention of this was, to ascertain separately the respective effects of a full South, of a full North, and of each kind of mean declination. In making up the results, the *Rain* for each of these quarters, ascertained by a separate calculation and corrected for the elevation of the gauge, is likewise inserted. The results are,

" 1. For the quarter-period in which the Moon was in Full South declination:

Barometer	29·852 in.
being above the general mean	·038 in.
Thermometer	48·57°
being below the general mean	·01°

Rain 3·56 inches.

" 2. For the quarter-period in which the Moon was coming North across the Equator,

Barometer	29·789 in.
below the general mean	·025 in.
Thermometer	49·57°
above the general mean	1·00°

Rain 4·96 inches.

" 3. For the quarter-period in which the Moon was in Full North declination,

Barometer	29·724 in.
below the general mean	·090 in.
Thermometer	48·66°
above the general mean	·08°

Rain 6·67 inches.

" 4. For the quarter-period in which the Moon was going South across the Equator,

Barometer	29·881 in.
above the general mean	·067 in.
Thermometer	47·53°
below the general mean	1·05°

Rain 3·72 inches.

" Having constructed a similar Table for a space of 355 days, beginning the 28th of the 12th Mo. (Dec.) 1815, and ending the 17th of the same, 1816, I found the results as follows: the general mean of the Barometer being 29·723 inches; of the Thermometer 47·09°; the Rain taken at the level of the ground.

" 1st Quarter-period, Barometer . . . . . 29·797 in.
above the general mean . . . . . ·074 in.
Thermometer . . . . . 46·14°
below the general mean . . . . . 0·95°
Rain 6·65 inches.

" 2nd Quarter-period, Barometer . . . . . 29·793 in.
above the general mean . . . . . ·070 in.
Thermometer . . . . . 48·73°
above the general mean . . . . . 1·64°
Rain 8·21 inches.

" 3rd Quarter-period, Barometer . . . . . 29·559 in.
below the general mean . . . . . ·164 in.
Thermometer . . . . . 47·00°
below the general mean . . . . . 0·09°
Rain 9·99 inches.

" 4th Quarter-period, Barometer . . . . . 29·678 in.
below the general mean . . . . . 0·55 in.
Thermometer . . . . . 46·51°
below the general mean . . . . . 0·58°
Rain 5·49 inches.

" Summary of the Effects in these two years:

" 1. With the Moon full South.

Barometer .	1807	above mean, falling.		1816	above mean, rising.
Temperature		about mean.			at lowest average.
Rain . .		the minimum quantity.			near the minimum quantity.

" 2. With the Moon coming North.

Barometer .	1807	below mean.		1816	at highest average.
Temperature		at highest average.			at highest average.
Rain . .		much increased.			much increased.

"3. With the Moon full North.

Barometer .	1807	at lowest average.	1816	at lowest average.
Temperature		about mean, falling.		about mean.
Rain . .		the maximum quantity.		the maximum quantity.

"4. With the Moon going South.

Barometer .	1807	at highest average.	1816	below mean, rising.
Temperature		at lowest average.		below mean.
Rain . .		nearly at the minimum.		the minimum quantity.

"The most considerable and striking effect of the Moon's positions in declination here exhibited, is certainly that of the unequal distribution of the *Rain*: which I shall therefore first notice.

"It appears that, while the Moon is far South of the Equator, there falls but a moderate quantity of rain with us; that, while she is crossing the Equator towards these latitudes, our rain increases; that the greatest depth of rain falls, with us, in the week in which she is in Full North declination, or most nearly vertical to these latitudes; and that during her return over the Equator to the South, the rain is reduced to its minimum quantity. *And this distribution obtains in very nearly the same proportions both in an extremely dry, and in an extremely wet season.*

"The next point to be attended to is the Temperature, in which the two years exhibit (in this respect) some striking coincidences.

"In both years, the Temperature is at its highest average (for the period) while the Moon is coming North over the Equator. During her continuance in North declination, the temperature in both passes the mean of the period, descending. In the *dry* year, it attains its lowest average while she is proceeding South again: but in the *wet* year, this takes place in the following week, or while she is in full South declination.

"I have already exhibited for the year 1807, an unequal distribution of rain, as well as a periodical variation of Temperature, connected with the Moon's *phases* *. It will be proper for the reader's satisfaction to recur to these, and to show that both in 1807 and 1816, the effects which I have attributed to the Moon's position in declination, are distinct from those before shown to arise from her change of place in revolution.

* See page 15.

"The Moon was in her Third or Last quarter on the morning of the first day of 1807; she returned to the same phase, after having made twelve revolutions in her orbit, early in the morning of the 22nd of the Twelfth month (Dec.) of that year.

"There was a New Moon on the afternoon of the 30th of 12th Mo. (Dec.) 1815; and again, after twelve revolutions, on the 18th of the same month 1816.

"The reader will find, on comparing these intervals of time with those taken for the declination, that *thirteen* periods of the latter nearly correspond with twelve revolutions; consequently the Moon must have presented every variety of phase, during these spaces, in conjunction with any given degree of North or South declination; and every variety of the latter together with any given phase: a state of things which effectually precludes us from ascribing to the one, any variation presented, *upon the whole of a nearly coincident space of time*, by the other.

"The diminution of the average rain, for the weeks of Full South declination, was therefore, in 1807, independent of the dryness before attributed to the influence of the Full Moon in that year; which was a still more striking phænomenon. Let us see how the case stood, in this respect, in 1816.

"Having divided the rain for this year also, according to the phases *about*, and *between* which it fell, and likewise computed the mean Temperature for each of the spaces (which are here denominated weeks), the results are as follows:

"In 1816,	For the week *about* New Moon .	Rain 6·11 in.	Temp. 47·10°.
	For the week *about* First Quarter,	Rain 10·10	Temp. 46·60°.
	For the week *about* Full Moon .	Rain 9·13	Temp. 47·17°.
	For the week *about* Last Quarter .	Rain 5·51	Temp. 48·39°.
		Total 30·85 in.	Mean 47·31°.
	For the week *after* New Moon .	Rain 5·21 in.	Temp. 46·85°.
	For the week *after* First Quarter .	Rain 12·49	Temp. 46·88°.
	For the week *after* Full Moon . .	Rain 7·41	Temp. 47·78°.
	For the week *after* Last Quarter .	Rain 4·20	Temp. 47·75°.
		Total 29·31 in.	Mean 47·31°.

"The Full Moon week in 1816, instead of being distinguished for dryness, as in 1807, was excessively wet: the greatest depth of rain, however, fell in the space intervening between First Quarter and Full Moon, and the *driest* part of the space included in each Lunar revolution was *in the opposite part of the orbit*, between the

Last Quarter and New Moon. The reader has only to turn over the Tables, from 114 to 126 inclusive, in the First volume, to be convinced of the fact in each instance *. With the exception of the week following the Summer solstice, in which there fell heavy rain before and after New Moon, the weight of the rain, this year, lies, in a very remarkable manner, within and about the third week of each period, or the space above mentioned; until we come to the latter part of the Eleventh Month and beginning of the Twelfth; when this space suddenly becomes *dry*, and that following the next Last Quarter becomes *wet*. It is observable, though I do not pretend to establish a connexion between the phænomena, that a Solar and a Lunar Eclipse are included in this period, which is so conspicuously dry in this very wet year, the rain being only half the average quantity of the season.

"I have remarked that the Lunar orbit, in 1816, appears to have had *a wet and a dry side*, as regards the Moon's influence on the rain of our climate. It appears likewise from the preceding statement, that the Mean Temperature, taken about the Phases, was highest for the Last Quarter and lowest for the opposite part of the orbit, or First Quarter, passing through a mean state for the intermediate phases, of New and Full Moon. Thus the *cold* aspect of our attendant planet was, in this year, also the *wet* one; and the same arrangement that brought more warmth, brought also comparative dryness†. And this, (as in the very dry year of 1807,) subject to a distinct and independent effect produced by the Moon's declination; to the consideration of which we may now return.

"In order to place in a more striking light the effect of the Moon's *declination* on the Barometer, as well as to show the agreements and differences in this respect, of a very dry and a very wet year, I have given, in Plate III., four periods of 1807, and as many of 1816, taken in each case from the winter and spring; in which seasons these effects are the most conspicuous. These curves represent the movements of the Barometer from the day of the Moon's crossing the Equator, going South, to that of her return in the same direction to the same position. The regular curve, which accompanies them in each figure, represents the Moon's course in declination, the horizontal line being the Equator. In the *upper* figure, the curves are constructed from the *medium* height of the Barometer for each day, each of them having its mean point in the horizontal line. Consequently the reader, knowing the mean of the period,

"* In Table 123, the marks Full M. and 1st Q. have been accidentally transposed." In the second edition of the Climate of London this is virtually corrected, by an alteration in the mode of indicating the phases, adopted in that edition.

† On this subject see the preceding Section.

with the time of its beginning, and availing himself of the help of an Ephemeris, for the successive times of the extreme South and North declination, &c., may verify for himself, by the Tables from 2 to 6 inclusive (vol. i.; second edition, vol. ii.), the accuracy of these delineations; the regular appearance of which, in some parts, may seem not unreasonably to require proof by measurement. Yet they are the result of observations, made without the remotest conception of their being ever applied to this standard, and in a manner which I cannot but consider, now, as imperfect.

"The *lower*, or second set of curves, give the variations of the Barometer at their full extent, as recorded on the face of the clock, of which I have already given an account in the *Introduction* [to the Climate of London, first edit. vol. i. p. xiii, second edit. vol. i. p. x; and in the Barometrographia, Introd.; and Notes, Hist. and Illust. 1834]; and in consequence of their showing all the smaller variations, which are sunk and lost in the curves constructed from medium heights, their general appearance is very different from the former.

"These curves will be found to agree nearly, but not exactly, with the observations in the Tables [Climate of London] from 114 to 117 inclusive; the latter having been obtained not from the clock, but from a Barometer in the ordinary way.

"In the third or *lowest* figure, the four sets for each year are respectively reduced to a mean curve, which is adapted to a common mean line: and a medium curve, passing between these two, exhibits, finally, the total or average effect of the declination on the Barometer, for the whole of the space taken for this examination.

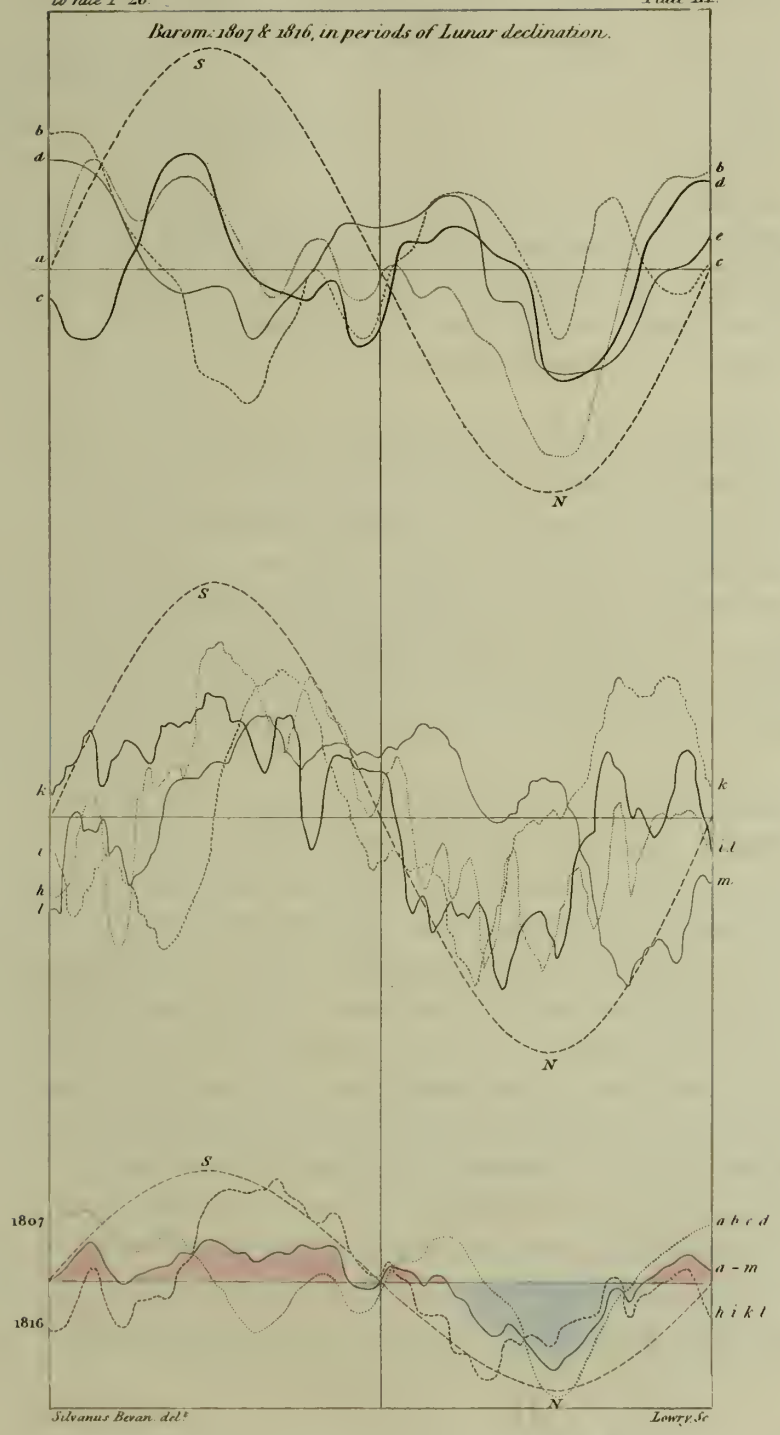
"Time of beginning, and mean height of the Barometer (represented by the horizontal line), for each of the curves in Plate III.

"For 1807.

"Curve *a*—*b*	begins	30–31 of Dec.	1806;	mean line at	29·97 in.
b—*c*	,,	26–27 of Jan.	1807;	,,	29·76 in.
c—*d*	,,	23 of Feb.	1807;	,,	29·92 in.
d—*e*	,,	23 of March	1807;	,,	29·79 in.

"For 1816.

"Curve *h*—*i*	begins	23–24 of Dec.	1815;	mean line at	29·64 in.
i—*k*	,,	19–20 of Jan.	1816;	,,	29·66 in.
k—*l*	,,	16 of Feb.	1816;	,,	29·64 in.
l—*m*	,,	15 of March	1816;	,,	29·79 in.


Barom.r 1807 & 1816, in periods of Lunar declination.
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Lowry Sc

" For the whole.

" Curve *a*, *b*, *c*, *d*. Mean of 4 periods of declination, beginning 30 of Dec. 1806, ending 19 of April 1807 . . . . . 29·86 in.

" Curve *h*, *i*, *k*, *l*. Mean of 4 periods of declination, beginning 23 of Dec. 1815, ending 11 of April 1816 . . . . . 29·68 in.

" Curve *a*—*m*. Mean of the above 8 periods . . . . . 29·77 in.

" It will be convenient to begin the examination of these curves with the last or general one, which, it will be recollected, gives the daily mean heights of the Barometer through a period of declination, upon averages of eight days each; the observations taken in seasons remote from each other, and under all the variety of weather to which the winter and spring months are incident: consequently, in a manner calculated to secure the fairest results.

" The general appearance of the curve *a*—*m* confirms the position already deduced from calculations on a larger space. It is, for the most part, above the general mean during the Moon's continuance in South declination, and below it during her North declination. The depression for the latter is, moreover, the most regular part of the whole variation; its crisis coinciding very nearly with the time of the Moon's beginning to return South, and the times of its departing from and returning to the mean being symmetrical. In this part also, the respective curves of the dry and the wet year present appearances the most nearly alike; and it is observable, that in the dry one the curve descends lowest.

" The curve also runs highest in the wet year, on the South side of the period; where we find the greatest difference, and indeed opposition, to prevail. While the Moon proceeds towards the South from the Equator, the Barometer of the dry year, which had risen at the going off of the Northerly depression, falls; and that of the wet year, which had continued, as it were, struggling below the mean, rises. Two or three days after the Moon has begun to come back from the South, each of the curves again changes its direction; that of the wet year now enters on a fall of ten days, which carries it across the mean to its lowest point for the whole period: that of the dry year rises for nearly an equal space, attaining a moderate elevation above the mean; from which it passes into the Northerly depression. Thus the wet year has the Barometer at a high level for a week only, while the Moon is approaching the Equator from the South, and the remainder of the period may be said to be nearly occupied by depressions: and the dry year is subject to a considerable depression, during the week of Full North declination; the rest of the period being chiefly occu-

pied by a mean or elevated Barometer. And supposing a rule to be found, for the periodical return of such extreme wet and dry years, we have here (so far as regards the winter months) a pretty certain method of anticipating the time of the occurrence of storms, in the fair season, and of fair and moderate intervals, in the wet and stormy one. Such are the mean movements of the Barometer, in these two seasons so opposite in their character, for the winter and early part of spring. We may now therefore advert to these curves singly, or as groups, in order to inquire into the attendant winds, and other circumstances.

" The elevations belonging to the week in which the Moon was crossing the Equator, southward, in 1807, constituting the extreme parts of the four curves, were accompanied by winds from the *South-west*, *West*, and *North-west*. There appears but one observation of N.E. and two of E. in this interval, and not one of a South wind.

" The movements, in 1816, for this space, in which depressions predominate, had winds from the *South-east*, *South-west*, and *West*. Three or four cases only of a Northerly wind appear, along with the great elevation in curve *i*—*k*, continued in *k*—*l*. This was at the going off of the severe frost of that season, in which the Thermometer stood a whole night at 5 below the zero. The crisis of the Barometrical depression, on this occasion, fell on the morning of the 7th of February, which is the date of the lowest point of the curve *i*—*k*; and the same winds which brought that intense cold, produced also the great rise of the Barometer.

" For the week of Full South declination we have, in 1807, for the most part *North*, *North-east*, and *West* winds: the depression at this time in the curve *b*—*e* was effected by South, South-west, and West winds. In 1816, we have for this space an alternate play of winds; the *South*, *South-west*, and *North-east* predominating in *h*—*i* and *k*—*l*, and the *North*, *North-east*, *East*, and *South-east* in *i*—*k* and *l*—*m*, with appropriate movements in the curves. The curve *i*—*k* exhibits a fine upward sweep of five days under N.E. and N. winds, after being three days depressed by the South-east: the crisis of these two movements will be found in Table 115 [Clim. of Lond.] at the 24–25 of January. Table 114 will also furnish interesting particulars of the curious sudden depression, immediately preceding the great rise which distinguishes this portion of the curve *h*—*i*.

" We come next to the week of mean declination, the Moon going Northward, in which the two movements again cross each other. The winds here are, in 1807, the *South-west*, *West*, *North*, *North-east*, and *North-west*, without any South or South-east; and in 1816, the *South-west*, *South*, *West*, *North-west*, and *South-east*; without

any North or North-east, till we come towards the close of the series. Hence the curve *l*—*m* presents an exception; being kept up for five or six days, where the others fall, by North-east and East winds, and at length falling (out of course and where the others rise) by the progress of the wind to South-east and so round to the Westward. This exception, which followed the Vernal Equinox, (see Tab. 117,) extended also to the weather, there being hereabouts seventeen days in succession free from rain, the longest *dry* space in this year!

"If we now turn back to the curves for 1807, we shall find in *a*—*b* a parallel exception. This curve, in crossing the mean line, *descends* on the whole, from the 11th to the 16th of January, with a fine movement of decreasing undulation, and with the winds as follow; W., S.W., N.W., W., S.W., N.W. It then enters upon the regular depression for North declination: for the particulars attending this and the preceding movement, the reader may consult Table 3. in the First volume [Clim. of Lond. second edit. vol. ii.]. It is probable these movements will be found, hereafter, to be necessary compensations in an extensive system of variations.

"There remain now to be considered only the depressions in the week of Full North declination. In 1807 these are very regular, and their crisis agrees nearly with the Moon's being furthest North: in 1816, on the contrary, we see them accelerated or retarded; so that the crisis, (where it can be defined,) lies considerably on one side or the other of this point. The difference would have been still more perceptible, had the curves of 1816 been formed, like the other, from *medium* observations.

"These depressions are not necessarily attended with gales of wind or heavy rain, at the place of observation. The crisis of that in the curve *b*—*c* was, however, connected in our [London] district with a very severe gale from the N.E., with snow and electrical discharges from the clouds; as that of the curve *a*—*b* probably was, with a storm at a considerable distance, in Devonshire, which appears by the accounts in the papers to have done much damage. See the dates, January 21, February 17, March 17, and April 13, in the Tables from 3 to 6 inclusive.

"In 1816, however, the desultory movements of the Barometer in the lower part of the scale, in this space, did not in many instances balk the observer's expectation, and there occur in the Tables from 114 to 117 inclusive, all the varieties of foul weather, in connexion with them.

"With regard to the *direction* of the winds in this space; in the four periods of 1807, the South-west predominates, and next to it are the North-east and North-west, the South-east again absent: but in 1816, the winds are a perfect mixture,

there being no point without at least two observations, and the South-west only considerably exceeding in number.

"The fairest mode of comparing the winds for these spaces is, however, upon the whole year. I have accordingly taken out the observations of these two years, in spaces answering to those of the Table of Quarter-periods of declination for 1807, p. 246–247 (second edit. vol. i. p. 176); and those of a similar Table formed for 1816, the results of which are given with the former."

Two tables are next given, pp. 262–265 (second edit. vol. i. p. 190–193); exhibiting the "*Proportions of the different Classes of Winds, in Quarter-periods of Lunar declination*, from the 3rd of the 1st Mo. (Jan.) to the 23rd of the 12th Mo. (Dec.) 1807; being 355 days, or 13 periods of declination," and from Dec. 28, 1815, to Dec. 16, 1816, being the same number of days and periods. Of both tables it is said, "The spaces taken are, as nearly as possible, those which have the Moon's greatest N. or S. declination, or her position on the Equator in their middle. The winds are taken from the Tables in vols. i. and ii."

To these tables succeeds a "Summary of the distribution of the winds according to the Moon's declination in 1807 and 1816.

"1. With the Moon full South.

	N.—E.	E.—S.	S.—W.	W.—N.	Var.	Days.
1807 . . .	21	6	19	38	6 —	90
1816 . . .	18	17	29	21	4 —	89

"2. With the Moon coming North.

1807 . . .	15	13	24	26	8 —	86
1816 . . .	16	21	33	17	4 —	91

"3. With the Moon full North.

1807 . . .	13	3	31	22	22 —	91
1816 . . .	17	15	26	21	8 —	87

"4. With the Moon going South.

1807 . . .	11	12	30	27	8 —	88
1816 . . .	11	10	22	35	10 —	88
	—	—	—	—	—	—
"Totals 1807 . . .	60	34	104	113	44 —	355
"Totals 1816 . . .	62	63	110	94	26 —	355

"The two classes N.—E. and S.—W. are of nearly the same *total amount* in the

wet, as in the dry year. The character of a whole year, in this respect, does not appear to be decided by either of them; but rather by the class E.—S., which has nearly twice the amount in the wet year that it exhibits in the dry: and this excess is taken out of the class W.—N., and out of the *variable*. In regarding the year as a whole, it is also proper to remark, that a much greater quantity of air undoubtedly passed over us, in all directions, in 1816 than in 1807. The large amount of variable winds, which appears under the Full North declination for 1807, is clearly raised at the expense of the E.—S. and N.—E. classes. I am not conscious of having used less care respecting these classes in 1816; and am inclined to believe that, during the fine season of 1807, there prevailed a much larger proportion of variable *Easterly breezes*, than of *winds* from either of these quarters. It seems to be one of the conditions of such a season, that the air of the district shall not hastily travel out of it, nor that of a distant one suddenly invade it. *A windy season can hardly fail, in some part of it, to be a wet one.*

"The distribution, as well as the amount, of the N.—E. is nearly alike in the two years. I shall therefore leave it for the present, to attend to the next in order.

"The class E.—S., which I have already characterized as the principal *importer* of our rains in Spring and Summer, appears to make its way into this district chiefly while the Moon is approaching from the South. The air being thus vaporized to the degree required for the moderate rains of the season, this wind falls off, in the dry year, during the week of North declination, to a very inconsiderable quantity: but in the wet year it is reduced to its minimum only during the return of the Moon to the South.

"The class S.—W. follows nearly the same rule. It increases as the Moon comes North, and decreases as she proceeds South again: but it is more fully manifested, under Northerly declination, in the dry, than in the wet year; continuing nearly undiminished until the Moon is Full South.

"Northerly winds are of course more frequent in those seasons when the Southerly fall off. They were at their height, in 1807, in both classes, under Full South declination: the W.—N. in this year, came to their minimum in the week of North declination, the N.—E. not until the following week, when they were only at about half their greatest amount. In 1816, the class W.—N. appears to have supplied the place of the N.—E., while the Moon was going South; falling to half the number in the week of her return Northward, and exhibiting a mean amount in the intermediate weeks.

"This account of the Winds, compared with the summary of the effects on the

Barometer, Temperature, and Rain, in page 251, (second edit. vol. i. p. 180.) may supply us with a key to many of the facts there stated.

"A general tendency in the Northern atmosphere to come over us, while the Moon is far South, may be admitted as a cause why the Barometer at this time is above the mean, the Temperature about or below it, and the Rains in small quantity.

"As the Moon comes North again, the air returning from the South causes increased temperature: it brings also a great increase of vapour, and the heat evolved during the condensation of this, may possibly be the means of the greater elevation of the mean Temperature at this time, in the wet, than in the dry year. Something must however be attributed, in this case, to the actual translation of more of the tropical air into these latitudes, in a wet season. The increase of the rain at this time, in both seasons, is a necessary consequence of the other arrangements.

"Why the Barometer should now be below the mean in the dry, and at its highest average in the wet season, is not equally apparent: but we may further notice its movements in the conclusion.

"Under Full North declination, we have the results of the previous introduction of vapour by Southerly winds. In the dry year, the vapour is decomposed [condensed] in a short space of time, and the attendant gales of wind are single and decided: in the wet, a longer continuance, or a greater number of repetitions of this process, together with the larger product of rain, indicate the operation of numerous currents from distant regions. In each season, these causes suffice to bring the Barometer to its lowest average, and the temperature to the mean.

"While the Moon is returning to the South, the winds from West to North predominating, in the wet year, tend to raise the Barometer and reduce the Temperature. The latter effect may also be now accelerated by Evaporation, as the rains decrease again. It is remarkable that, in 1807, the Barometer shows the highest average for this week, and the Temperature the lowest, with the smallest proportion of N.—E., and nearly the largest of S.—W. winds.

"The course of the varying density of the atmosphere in its relation to the Moon's declination, is pretty fairly represented as to direction, though not as to extent, for the whole of the two years, by the specimen given in the two mean curves, *a*, *b*, *c*, *d*, and *h*, *i*, *k*, *l*, in Plate III. It will be important, hereafter, to ascertain fully the principles of these two modes of variation; as they appear, more than any other circumstance (the disproportion of the South-east winds excepted), to mark the difference between a wet and a dry season; and their periodical causes being once known, the return of such seasons may be predicted with some degree of certainty. I consider

the scheme which I have given early in this inquiry (second edit. vol. i. p. 5) of the varying *mean Temperature* of the years, as calculated in great measure to answer this purpose; it being very clear, that the greatest depth of rain fell in the coldest years, and that the warm years were dry or mean ones. But it will be a great addition to this information, should we be able to prove, from observations now extant, that the Barometer also varies its mean height periodically, *from year to year*; and that both variations are governed by a periodical succession of the different classes of winds*.

"If the Moon's attraction be really the principal cause of those variations in the atmosphere which cannot be traced to the influence of the superior planet, the mode of operation of this attraction may be very simple; at the same time that, considering the complicated nature of the Lunar orbit, and the perpetual interference of the Sun's varying power, its manifestations in any given temperate climate may prove a very difficult subject to investigate.

"On a train of effects, the most part of which are out of the reach of direct observation, we may be permitted, in this part of the work, to hazard a few conjectures.

"The surface of the atmosphere is, I think, less elevated, and better defined, than many persons would be led to imagine it. A portion of air, rarefied by means of the air-pump, does indeed exhibit an elasticity, which seems limited only by the imperfection of the instrument. For the most minute residuum still appears to fill the vessel, and to press against it in all directions. But it does this at a *temperature* which, compared with that of the extreme boundaries of the atmosphere, is probably as that of the steam in a high-pressure engine to the water in a well. We know that, in ascending in the atmosphere, the temperature is found to decrease with the decreasing density of the air: and even under a vertical sun, between the Tropics, a line of perpetual snow on the mountains, indicates a boundary within our reach, which the heat never has ascended *in mass* to penetrate. There is consequently no source from whence air, conveyed to the summit of the atmosphere, could take the heat necessary to such extreme rarefaction; the whole sensible heat of the atmosphere being derived originally from the earth's surface, and distributed in an inverse proportion to the elevation. At an elevation, therefore, not perhaps on a mean more

* The proofs of these positions were adduced by Mr. Howard in five papers communicated to the Royal Society from 1840 to 1845, abstracts of which are inserted in their proper places in the text above, of the preceding and present Sections, and which are given entire in Part II., comprehending all the papers relating to the "Variations" and "Proportions" of the meteorological elements in question. The subject is alluded to in the "Cycle of Eighteen Years in the Seasons of Britain," reprinted in the next Section. See also the paper "*On the Mean Year*," &c. communicated to the British Association in 1844, and noticed further on in the present Section.

than ten times that of the highest mountains, or fifty miles at the Equator, and considerably less at the poles, I conceive there exists a perpetual *zero* of temperature; and with it an effectual limit to the further expansion of the atmosphere. Here, the spheroidal body of gases, enveloping our globe, has probably a well-defined surface (its extent considered) where the air, though greatly attenuated, is much less rare than we can make it in the receiver of the air-pump; in a word, a fluid, with a surface capable of rising and falling, like the waters, by change of gravity.

"With such a surface, it is plainly possible that the atmospheric ocean may be acted on in the manner of a tide. It may be elevated and rarefied on the side directly opposed to the Moon, and at the same time on the opposite side of the globe; and left to its proper gravity in the remaining part of the mass. And it ought, on this supposition, to exhibit a more perfect example of a tide than even the waters; there being here no shores, as in the ocean, to retard the arrival of the swell at a given place, at the destined hour; or prevent its passing regularly round the middle regions of the globe, in the space of a revolution of the latter on its axis*. If I place my hand upon a spiral spring of wire, and depress it, the force being withdrawn the spring follows, and returns immediately to its former state. But if I do the same with a pillow of down, this elastic body, consisting of many small parts acting feebly on each other, takes a long time to resume its full dimensions. There is a similar difference in constitution between the ocean and the atmosphere: and it is very probable, that an interval of six hours is not nearly sufficient for the full effect of rarefaction, (the low temperature aloft considered,) and still less for the subsidence and condensation of the air, through its whole depth, to the degree required by the theory of such a tide. The *daily* alternate movements, then, of an atmospheric tide, perhaps from their not having been sufficiently sought among the continued fluctuations of the density of the air at the earth's surface, are not yet demonstrated: but both the Barometer and Thermometer supply, in their respective mean variations, most palpable instances of the weekly increase and decrease of those movements.

* "The Barometer, when we contemplate it as a counterpoise to the weight of the atmosphere, is certainly a curious instrument: its movements, unlike those of the Thermometer, which relate only to surrounding space, bring us intelligence from the very surface of the aërial ocean, many miles above our heads. Here, probably, exist elevations and depressions of prodigious extent; and as the representative in miniature of those tides in a sea without shores, its variations deserve, in point of theory, greater attention than has been hitherto bestowed on them."—*Climate of London*, First Edit. vol. ii. p. 145; Second Edit. vol. i. p. 59.

These views of the Author regarding the finite extent and definite surface of the atmosphere will be returned to at the close of the present Section.

" In a portion of the atmosphere, the most considerable in point of bulk, situated above the reach of the daily variations of temperature caused by the sun, the alternate rarefaction and condensation here supposed may take place, without producing any other consequence than a current from East to West, around the globe, in that region.

" In a lower portion, visited at different times by different proportions of the heat and vapour generated at the earth's surface, it may effect an alternate absorption and condensation of water, with correspondent changes in the Electrical state of this region; and thus contribute to decide the occurrence of strong winds, rain, thunder, and other occasional meteors, below.

" Still lower, in a region to which our observation more or less extends, the complexity of the causes must necessarily produce effects more difficult to appreciate; and these are brought about, as it seems, chiefly by the succession and interchange of lateral currents*. The rarefaction produced in this region by the Sun's heat, is admitted to give rise to a most regular and extensive system of these, commonly called the *Trade-winds*. The air around the globe over the Equatorial regions, expanded by the heat, rises, or is pushed upward by the contiguous cooler air from the North and South; the motion of which, combined with the larger motion of the earth's surface from East to West, as the latitude becomes higher, gives rise to a South-east wind on the South side, and a North-east on the North. Such is the admitted principle of the Trade-winds; and it is thought (indeed it must follow) that the air, thus elevated above the Equator, returns in some kind of currents, above the Trade-winds towards either pole. If we admit a constant Easterly *tide* in the higher tropical atmosphere, into which this rarefied air constantly rises, we shall have a powerful auxiliary to the Sun, in keeping up the Trade-winds; and if we admit that the Moon, by her alternate passage to the North and South in declination, sets this tide alternately to the Northward and Southward of the line, we shall have a principle on which to solve the greater abundance of rain, and the brisker flow of the variable winds in temperate latitudes, at that season when the Moon becomes vertical to them, than when she is in the other hemisphere. We want indeed, on this point, the concurrent testimony of observations made in some temperate climate, South of the Equator: though we know already that their *polar* winds raise the Barometer, while the *Equatorial* depress it; following the same law as with us, though moving in an opposite direction.

" The air which flows from the North and South towards the Equator, is felt as

* The subject of lateral currents in the atmosphere will be noticed subsequently: see also pages 31 and 39 in the present Section, and page 9[a] of Part II.

an Easterly wind, because it comes from parts of the earth's surface, which have a smaller motion from West to East, than the region into which it is entering: but it gradually acquires the rotary velocity proper to that region. In returning to the temperate latitudes, it has again to lose this Westerly momentum: and this seems to be the principal cause of the great preponderance of Westerly winds in our own climate. We have seen [Climate of London, first edit. vol. ii. p. 157; second edit. vol. i. p. 76], that on a mean of ten years, the Westerly were to the Easterly winds as 225 to 140; while the Northerly and Southerly winds balanced each other within 21 days. A wind, coming to us from a considerable distance South, whatever be its velocity, must therefore be felt as a South-west wind: and as the Trade-winds, at certain seasons, appear to have their subsidiary streams or appendages reaching far into the colder latitudes, so these Tropical Southerly gales occasionally make their inroads upon us with greater violence, and for a longer season than usual. It is not unlikely that the British Isles, in consequence of their latitude, and from their being as it were a part of its Western barrier, may be the very part of Europe the most exposed to them. A North-east wind, kept up by rarefaction caused by the sun, must find the easiest course upon land; while a South-west, consisting of air which has to descend upon the earth, and spend the momentum it has acquired in more Southern latitudes, is more likely to get easily over the surface of the ocean, and to be arrested by the asperities of the first extensive fixed surface which it encounters. This state of things prevailed remarkably, near the close of the winter of 1817, after a long course of violent Westerly gales; when, as far as we may judge from the reports of navigators, the North-east current was for many days no further to the South of us than the coast of Portugal, without our feeling even the skirts of it.

"It is remarkable nevertheless, that on a mean of ten years, ending with 1816, and indeed in most of these taken separately, the winds to the North and South of West should so nearly balance each other, as that their averages stand 100 : 104. I know of no reason which can be given for this, equally satisfactory with that of their receiving a direction to North and South alternately, by the Moon's different positions in declination: an effect which, although not to be found in the winds of a particular district, in every Lunar revolution, is yet detected in a long average.

"On the whole, it may be inferred that the winds in a temperate latitude like our own, after escaping from the Tropical vortex, become subject, in winter more especially, to the Moon; and that their tendency is, to follow her path, or the moveable point of greater rarefaction which she marks out for them. Thus it appears from the statement, p. 266, [second edit. vol. i. p. 194] that during her approach to

these latitudes, in declination, in 1807 and 1816, the winds from the West and North-west fell off in number. Now if we consider that the Moon's daily course from East to West (which though only apparent has here the same effect as the real,) was coupled, during these weeks, with a motion from South to North in declination, it will appear that a South-east wind would now, in effect, follow her course, and a North-west flow in opposition to it. And in 1816, during the weeks in which the Moon was receding in declination to the Southward, and thus offering daily less and less resistance to a North-west wind, this class of winds amounted to double the number which they exhibited in the former case. Again, in both years, and especially in 1807, the class of winds from North to East, which are plainly most influenced by the Sun, appeared in the greatest number while the Moon was in Full South declination, and when consequently there was little of the rarefaction, which she is here supposed to produce, in these latitudes.

" The succession and proportion of the winds are consequently subject to a periodical variation from year to year: but the period in which the same or a similar set of winds comes around again, cannot at present even be conjectured. From the effects produced in our [London] district, on the average temperature of the years, and on the depth of rain, it may seem to have some connexion with the Lunar cycle of 18 years. But this is a subject well worthy of separate and more deliberate investigation*."

In the " Summary" of results in the order of the seasons, as presented by the climate of London, near the conclusion of the work, Mr. Howard observes,—"It is demonstrable, from abundant evidence, (enough of which is even contained in this volume,) that we owe most of *our vicissitude*, even in temperature, to the *Moon*. It appears that our attendant planet, principally, if not solely, by the effect of gravity, continually disturbs the density of the atmosphere, producing, in the temperate latitudes of the globe, a *variety of currents*, the different qualities of which, in respect of temperature, moisture, and electricity, are developed as they successively pass over. Hence great *variety of weather*;—this, however, on the great scale of the year, is regulated by the more or less predominant influence of the Sun, according to his place in declination: which secures to us the enjoyment of our *four seasons* in succession, these minor fluctuations notwithstanding.

" I have shown that the great fluctuations in the density or gravity of the atmosphere, in our climate, are principally due to our participation, by turns, of the Polar

* The results of the investigation here contemplated are given in Section III., and in the paper commencing at p. 43[a].

and Tropical atmospheres; between which we are situate. But our position in Summer, when by the inclination of our pole towards the Sun we are presented in a more direct manner to the rays, approximates the habits of our climate to those of the equatorial regions; and we thus become more uniform, both in temperature and density, than at any other season;—though still greatly more variable, in both respects, than the countries in that part of the globe. In proportion as the Sun rises higher, and continues longer above the horizon, the Moon, to whose influence I have attributed the variable winds of our climate, becomes depressed, as to our latitudes. Her influence, consequently, is diminished, and that of the Sun, to which we have seen ascribed a more uniform action on the winds, is established in its place. Such appear to be the reasons, why the Barometer varies so much less in summer than in winter: but its movements in ascent or descent in this season, are not therefore the less indicative of those changes in the density of the air, on which the weather, in some considerable degree, depends."—*Clim. of Lond.* First edit. vol. ii. pp. 293, 302–303; Second Edit. vol. i. pp. 240, 247–248.

Mr. Howard's "Meteorological Report for the year 1820 in the vicinity of London," read before the Royal Society in the following year, and printed at large in this work, page 1[a], has already been noticed (page 15), so far as the influence of the moon according to her position in her orbit is concerned. With respect to her influence in declination on the weather of that year, it is recorded in this report, that while she "approached us in her course northward, the winds from north and south were so distributed as almost exactly to balance each other in frequency; and that while she receded southward, the northerly preponderated by a fourth part over the southerly winds; and this alike, whether she was north or south of the equator." Regarding this arrangement as the key to the remaining phænomena of the year, the author found a less height of the barometer, and a lower mean temperature, in the north course of the moon, and consistently with these results more rain in the proportion of 3 to 2 for the north course, than for the south. The concurrent or complementary influence of declination and the phase, as noticed in the former abstract, is next considered; and when discussing the configuration of the curves in the plate (I[a]) representing the variation of the barometer for the thirteen periods of declination from the 24th of December 1819, to the 12th of the same month in 1820, the relations of those curves to the position and course of the moon in declination are pointed out in detail. Attention is especially called to the *compensating* movements, of which it is the consequence, "that the heights of the barometer, taken on an average of thirteen periods,

nearly coinciding in extent with a solar year, show so nearly alike for the spaces in which the moon is north and south of the equator;" while, in a succession of particular periods, more especially in winter, the effects of her position, or of her *course* north and south (as already shown in the present Section), are conspicuously opposite. The examination of these results for the year 1820 disposing the author to regard occasional compensations, *in every part of the period or meteorological year* under consideration, as necessary to a system of movements caused by lunar influence, he discusses, in conclusion, the theory of these compensations, observing, among other circumstances, that "when a certain portion of air" (in consequence of rarefaction caused by the moon's attraction,) "moves northward, an equal or proportionate volume, according to the density of each, must flow from north to south to replace it;" and that "it may do this in a superior or inferior," or (which he considers more probably the case in the main,) "in a *lateral* current," in a region less subject for the time to the direct lunar influence. Mr. Howard's views on this subject, however, can only be adequately apprehended by the study of the Report itself and of the numerical and other observations which accompany it, in connexion with those which are presented in the former part of this Section on the Moon's influence in Declination.

In the second edition of the "Climate of London," the discussion of the Moon's influence on the atmospheric pressure and other meteorological elements, according to her position or course in declination, remains as it had been originally made public in the first edition, and as here given; with the exception of a few very slight verbal additions and interpolations, all which have been adopted in the preceding pages.

In the "Lectures on Meteorology," the subject of the action of the Moon in declination on the Barometer is thus summarily stated, in the fourth lecture:—

"The far greater part of the more considerable movements of the column are found to be, after all, periodical, and of the nature of tides; being governed, like the tides of the Ocean, by the Moon's phase, or place in declination—and most, by the latter.

"The more obvious *weekly tide*, (comparable to the neap and spring of the sea-tides,) which is conspicuous in the curves of the Barometrical variation for these latitudes, has been more often observed and speculated upon [than the daily tide]. There is a constant tendency *in the ordinary variation*, to show two elevations and two depressions in each Lunar revolution, or in a period of twenty-eight days.

These manifest changes are, however, often set aside by a variation of a different character, more especially in seasons of continued rain and storms. They are connected both with the Moon's place in its orbit, and with its declination North or South of the Equator.

"By the *declination*, the dry and the wet year agree in the distribution of their Rain: and this distribution, so far as it can be reduced to a common principle, appears to be as follows: *While the Moon is far South of the Equator, there falls but a moderate quantity of Rain in these latitudes: while she is crossing the line towards us, our Rain increases; and the greatest quantity falls, while she is in Full North declination—or most nearly vertical to us: but during her return to the South, the rain comes back to its lowest amount.*

"The Mean Temperature, again, appears to increase along with the Rain, and to decrease as the quantity of that is reduced; agreeably to the known principle that heat is extricated by the condensation of vapour, and passes into the air." "Seven Lectures on Meteorology," First edit., p. 69, 79–80, 81–82; Second edit., p. 82–83, 95–96, 98.

At the beginning of February 1841, Mr. Howard communicated a paper to the Royal Society, which was read on the 11th of March, entitled "On a remarkable Depression of the Barometer in November 1840, agreeing very closely in its movements and results with that of December 1821." The depression of 1821 here alluded to, he had described in a paper inserted in the Philosophical Transactions for the succeeding year. Both papers are given, at pages 13[a] and 32[a], in the second part of this Appendix.

"The object of the author in the present paper," according to the notice contained in the Proceedings of the Royal Society, vol. iv. p. 292, "is to show the close correspondence of the extraordinary depression of the barometer in the months of October and November of last year (1840), and of the remarkably stormy weather which prevailed at the same period, with similar phænomena occurring in December 1821, when the Moon's place in declination underwent the same changes during those two periods, at an interval of nineteen years."

To this brief official notice, it is requisite, for our present purpose, to annex the following abstract of that portion of the paper which relates to the author's investigation of the concern of the moon's place in declination, in producing (or determining as to time at least) the two great falls of the barometer described in it;

—an investigation which he was led to undertake in consequence of being engaged in completing another paper for the Society, exhibiting a system of barometric averages ruled by the moon's place in declination, to which we shall refer in the next place.

The moon having been on the equator, December 3rd, 1821, twenty-two days before the crisis of the great depression of the 25th, and also on the 22nd of October 1840, twenty-two days before that of the great depression of November 13th, the author laid down on a scale of the barometer twenty-nine days of variation of *the daily mean height* in each case, the diagram thus produced being given in the paper. Referring to this, he observes, "It will be seen at once, that, thus placed together, the two variations agree (with each other and with the spaces of the period) in a manner which can be attributed to nothing (as the remote or ruling cause) but *the moon's change of place in declination.*" He points out, again, that "there is a swell in the curve of variation, in each case interrupting the continued descent, or rather preceding it, which corresponds in like manner with a south declination in 1840, and a north in 1821;" and that, moreover, the two curves correspond in figure generally, there being in each the same number of nearly simultaneous changes of direction, which set out at the beginning of the period from the same point, and return after the recovery very nearly to the same point of the scale again. With all these features of agreement, at once with the assigned cause, and with its period and division of time, Mr. Howard thinks no astronomer will be found hesitating as to the actual connection, but will at once pronounce these movements *an affair of lunar declination*—a problem which is to be investigated and solved on no other than astronomical principles.

The entire result of this investigation, he remarks, proved more striking than he had expected, the movements of the barometer in these two cases classing decidedly with those of the periods he had taken from the years 1807 and 1816, to exemplify this kind of variation in the "Climate of London";—and as already discussed in the present Section. Adverting, in conclusion, to the apparent discrepancy, "that in one case the moon was approaching from the south during the fall of the barometer, and in high north declination at the crisis; in the other, receding southward and over a distant latitude on that side the equator at the time of the greatest manifestation [through the barometer] of its power here," he refers in explanation to the nature and movements of the great tidal wave in the ocean, following new and full moon alike; admitting, however, that the winds may or may not be found *a principal mediate cause* of these variations, under the directing power of our attendant planet.

The subject was resumed in the Philosophical Transactions for 1841, in a paper entitled "On a Cycle of Eighteen Years in the mean annual height of the Barometer in the Climate of London, and on a constant variation of the Barometrical Mean according to the Moon's Declination."

Of this communication, which is reprinted at page 39[a] of the present work, the subjoined abstract appears in the Proceedings of the Royal Society, vol. iv. p. 292 :—

"For obtaining the general results communicated in the present paper, the author has followed the same method as that he had adopted in the two former papers laid before the Society, on the connexion of the barometrical variation with the lunar phases and apsides. Tables are given of the barometrical averages on successive solar years, from 1815 to 1832, so constructed as to exhibit the variation of the moon's influence according to her declination ; and also of these averages on successive cycles of nine solar years, classed according to the moon's place in declination, on either side of the equator. The results deduced from these comparisons are, first, that the barometrical mean in this climate is depressed by the moon's declination being to the south of the equator; and secondly, that this depression takes place gradually, commencing with the moon's being in full north declination, and proceeding through her remaining positions to the time when she crosses the equator to resume the northern declination ; at which season the whole pressure that had been withdrawn from the atmosphere is suddenly restored. The author thinks there is evidence of a great tidal wave or swell in the atmosphere, caused by the moon's attraction, preceding her in her approach to, and following her slowly as she recedes from these latitudes ; so that were the atmosphere a calm fluid ocean of air, of uniform temperature, this tide would be manifested with as great regularity as those of the ocean of waters. But the currents uniformly kept up by the sun's varying influence effectually prevent this from taking place, and involve the problem in complexity. He finds that there is also manifested in the lunar influence a gradation of effect which operates through a cycle of eighteen years. The mean pressure of the atmosphere during the first part of this period increases ; and then, after preserving for a year its maximum amount, again decreases through the remaining years of the cycle, but exhibits, towards its minimum, some fluctuations before it again regularly increases."

As the requisite sequel and accompaniment to this investigation, Mr. Howard communicated to the Royal Society, in the same year, 1841, a paper "On the Proportions of the Prevailing Winds, the Mean Temperature, and Depth of Rain, in the Climate of London ; computed through a cycle of Eighteen Years on Periods of the

Moon's Declination." This paper will be found at page 43[a]. In the Proceedings of the Society the following abstract of it appeared, in which, however, the omission of the results which the author had obtained, with respect to the influence of the lunar declination on the amount of rain, has rendered necessary a considerable insertion.

"In this paper the author investigates the periodical variations of the winds, rain and temperature, corresponding to the conditions of the moon's declination, in a manner similar to that he has already followed in the case of the barometrical variations, on a period of years extending from 1815 to 1832, inclusive. In each case he gives tables of the average quantities for each week, at the middle of which the moon is on the equator, or else has attained either its maximum north or south declination; [the paper terminating with a Synopsis of the Winds, Temperature and Rain, computed according to the moon's declination, for the eighteen years under consideration.] He thus finds that a north-east wind is most promoted by the constant solar influence which causes it, when the moon is about the equator, going from north to south; that a south-east wind, in like manner, prevails most when the moon is proceeding to acquire a southern declination; that winds from the south and west blow more when the moon is in her mean degrees of declination, going either way, than with a full north or south declination; and that a north-west wind, the common summer and fair weather wind of the climate, affects, in like manner, the mean declination, in either direction, in preference to the north or south, and most when the moon is coming north."

"He finds the average annual depth of rain, falling in the neighbourhood of London, is 25·17 inches." [The average of the eighteen years considered in the paper comes out 25·61 inches; which, the author observes, though probably less accurate as regards the climate, is sufficiently so for his present purpose of examining the distribution. Proceeding to this, he finds that there falls most rain (by measure and at the surface of the earth) in the weeks in which the moon is (full) south of the equator; and least when she is passing over it southward; the full north declination, and the weeks in which she is approaching towards it, having a mean quantity. On investigating the connection of the rain with thunder, he finds that the atmosphere of our climate is sensibly more subject to electrical accumulation in the clouds, and to the consequent discharges, when the moon is either south of the equator or returning from that position.] From his observations on the temperature, he deduces the following conclusions:—1. That the pressure of an atmospheric tide, which attends the approach of the moon to these latitudes, raises the mean temperature 0·35 of a

degree. 2. That the rarefaction under the moon in north declination lowers the temperature 0·13 of a degree. 3. That the northerly swell following the moon as she recedes to the south further cools the air 0·18 of a degree. 4. That this cold continues while the moon is away south, reducing the mean temperature yet lower by 0·04 of a degree."

In September 1844, the author read before the Section of Mathematics and Physics of the British Association for the Advancement of Science, at its Fourteenth Meeting, held at York, a paper entitled "The Mean Year, or Solar Variation through the Seasons of the Barometer in the Climate of London;" which was printed, in a condensed form, in the Transactions of the Sections, inserted in the Report of that Meeting of the Association, p. 14.

In the introduction to the tables which constitute the principal part of this paper, as given in the Report, it is remarked, that "The variation of the barometer through successive months in any given year has been sufficiently shown to be connected with the lunar influence, by which the tides of the ocean are governed; and this influence, until more fully investigated, will continue to present difficulties in the use of the barometer as a weather-glass—the atmospheric *tides* requiring for this purpose to be set aside while we attempt to prognosticate results from currents of another nature. It may be useful for this purpose to have tables of the variation of the barometer (in connexion with the prevailing winds) *in which the lunar influence is set aside by proper averages.*"

The calculations thus tabulated were "made upon data to be found in the author's long-published work, 'The Climate of London,' and the years chosen, as most convenient for the purpose, extending from 1813 to 1830. A near approach is thus made to the cycle of $18\frac{1}{2}$ years, in the course of which it is presumed that the effect on our atmosphere of the various positions of the earth and its attendant planet, in relation to each other and to the sun, may balance and neutralize each other. The barometer is thus placed *in immediate connexion with the winds* proper to our climate; and with *the sun's place*, by which these are mainly governed."

Of the tables, two present the daily observations of the direction of the wind during eighteen years, divided into classes* and assigned to the several months and years of the cycle, etc.; and four comprise the daily mean of pressure, and notations of the wind for each day of the artificial or mean year in detail†. Two engraved

* These classes are explained in page 44[a] and in the Table page 61[a]. See also 'Climate of London,' vol. i. p. 74.

† The *construction* of the mean year, though assumed to be explained in the Report, is really left

diagrams (Plate 41 of the Report) also accompany the paper, the second of which exhibits, on an enlarged scale, the elevations and depressions of the daily mean of the barometer, "*independently of the effect of lunar influence*, in a curve which runs through the year by a regular movement of daily increase or decrease upon the climatic mean."

Mr. Howard's researches on the present subject terminate with a paper in the fourth part of the Philosophical Transactions for 1846, "On the Barometrical Variation as affected by the Moon's Declination," which, however, had been read before the Royal Society on the 19th of June 1845, having been communicated on the 16th of the preceding January, nearly two years previous to its publication.

In this communication (which is reprinted in the second part of this work at page 63[a]), the author continues the calculations given in his paper published in the Philosophical Transactions for 1841 (noticed page 42 above, and also reprinted at page 39[a]), first describing the method used to bring out the averages, the present series of which extends from December 20, 1832, where the former ends, to December 23, 1841. This series corresponds nearly with the subsequent or *cold* half of the cycle of annual temperatures, which he had already laid before the public in his work on "A Cycle of Eighteen Years," etc., now forming § III. of this Appendix. Referring to the mean height of the barometer for each of the four positions of the moon in declination brought out, in his former paper, by averages upon eighteen years ending with 1832, and to his inference therein made, that the barometrical mean is depressed in these latitudes by the moon's position in south declination, as well as to the gradual process of the depression, and the sudden elevation on the moon's return north, he shows that the results of the present examination differ somewhat in the proportions of pressure shown, the chief cause of which he apprehends to be the different latitude 53° 39′ north, (of Ackworth in Yorkshire,) in which a part of the observations were made. The instrument thus standing, from 1828, two degrees more to the north, and on considerably higher ground than at Tottenham, the averages still give the depression to the place of south declination; but with a check, amounting almost to the doing of it away, in the concluding position. Further, on the solar years, from 1833 to 1841, *observed wholly at Ackworth*, the former variation, presenting a gradual

unexplained. It is here added from Mr. Howard's original MS. "The *Mean year* is formed by the very simple operation of putting down the maximum and minimum of the Barometer from the Register for the same day through the whole Cycle, and noting the average of these observations in its place for the day. This operation being carried through the year, the mean results for the Months, for the Seasons, and for the whole Year are easily deduced:" such in fact are the results given in the Tables described above.

decline of gravity to the moon's south place, is replaced by one in which the loss of gravity by the north declination continues into the following week, and is restored (very nearly) in the fourth week; the moon yet full *south*. There must be something then, the author concludes, in the more northerly latitude, affecting partially the *mixed* average 1824 to 1832, and more completely the northern average 1833 to 1841.

Having in his former paper exhibited a set of averages *upon the whole solar year*, from 1815 to 1832, in which the *yearly mean pressure* increases to the middle of a cycle of eighteen years, and then decreases with great regularity to its former amount, he inserts in the present paper a similar calculation, but with an opposite result: which shows the pressure decreasing from year to year, and then recovering in some measure its former level. He proceeds to consider, in conclusion, the nature of this contrast, pointing again to the difference of latitude as its possible cause.

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§ III. A CYCLE OF EIGHTEEN YEARS IN THE SEASONS OF BRITAIN; DEDUCED FROM METEOROLOGICAL OBSERVATIONS MADE AT ACKWORTH, IN THE WEST RIDING OF YORKSHIRE, FROM 1824 TO 1841; COMPARED WITH OTHERS BEFORE MADE FOR A LIKE PERIOD (ENDING WITH 1823) IN THE VICINITY OF LONDON.

[This Section is a reprint, with corrections and additions, of the author's work bearing the same title, published at London, Leeds and Pontefract at the end of April 1842, in octavo. The Dedication, to the Earl Fitzwilliam, is dated "*Tottenham, March* 31, 1842." After the publication of this work, the author communicated a paper on the same subject to the Section of Mathematics and Physics of the British Association for the Advancement of Science, at its Twelfth Meeting, held at Manchester in June 1842. An abstract of this paper appeared in the Report for that year, in the Transactions of the Sections, p. 24, under the title of "On a Cycle of Eighteen Years in Atmospherical Phænomena;" accompanied by a Chart, showing the mean temperature, proportionate occurrence of the four classes of winds, and depth of rain, for each year of the cycle from 1824 to 1841.]

The fact of a periodical revolution, bringing alternate warmth and coldness through successive trains of seasons in our variable climate, is now ascertained beyond controversy; and it becomes in consequence an important object, to ascertain the nature

and extent of these changes, and their effects on our *agriculture* especially; that we may the better avail ourselves of the favourable, and provide against the adverse.

In my account of the climate of London, first printed in 1818—1820, I gave a view of these changes on the basis (which my observations then seemed to present) of *alternate periods of seven and ten years*, the former *ascending*, the latter *descending* in the scale of heat. I then admitted, from appearances, the probability of spaces between these successive periods not agreeing with the rule above mentioned, and answering to the "intercalations" of an imperfect calendar. Having since pursued the subject further, I find these spaces, or interposed years, to be necessary parts of the scheme at large; which now resolves itself into *a cycle of eighteen years*, in which our seasons appear to pass through their extreme changes in respect of warmth and cold, of wet and dryness. I have given an account already to the Royal Society of my views on this subject, as regards the seasons near London*, and what relates to the periodical variations of the barometer from year to year in this neighbourhood is inserted in the Transactions†. My present object is, to bring in confirmation of these views *the facts of a new period, observed in a new locality*, and that differing so considerably in latitude from the former, as to justify the inference that the periods are not confined to any part of our island, but will be found, variously modified, in all.

Referring to the papers above mentioned for a variety of facts relating to atmospheric periodicity, stated in a more elaborate way, I shall here briefly analyse the results of the Ackworth register, and apply them to my object; saying little about the *barometer* however, because the present observations on this instrument, however constantly made from day to day, have not the comprehensive character of those insisted on in my former papers; *which were taken from the face of a registering clock*‡. The Tables annexed to this paper, then, comprise the *Results of a daily meteorological register*, kept at my instance, and with instruments furnished by myself, *at the Friends' Public School in Ackworth*. I have observations, not so continuous, made at my own residence there; by collation with which in many parts I have satisfied myself that I can depend on *these*, for the purpose to which they are here applied, of deducing the differences of seasons from previous and subsequent ones of like denomination, *by comparison with each other*.

As on former occasions, I shall have recourse to *diagrams*, which present to the eye

[* This account will be found in the paper given in the Second Part of this Appendix, page 43ª.]

† Philosophical Transactions for 1841, Part. II. [Reprinted page 39ª].

[‡ See INTRODUCTION.]

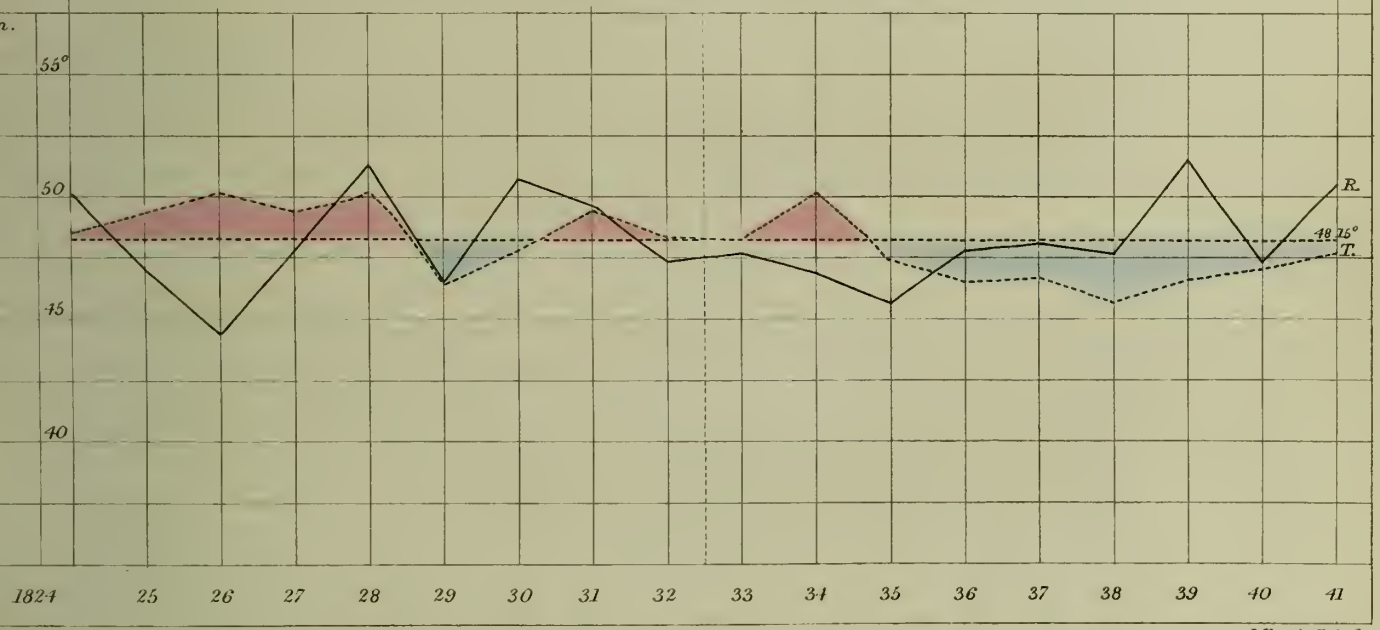
with ease what figures would convey but slowly to the mind. The *dotted* curve, or flexuous line in fig. 1. (Plate IV.) shows the variation from year to year of the mean temperature, or *average heat* of the year; the *Mean of the climate* (or average of all the observations of these eighteen years) being 48·126°. The nine years from 1824 to 1832 average 48·879°; the nine years from 1833 to 1841 give 47·374°. The difference of 1·4° is about equal to the difference in warmth between Ackworth, N. lat. 53° 38′.40·8″, and London. I therefore call the former nine the *warm*, and the latter nine the *cold* years of the cycle. The curve shows palpably the bulk of the years of high temperature to the left, or preceding, and of those of low temperature to the right, or following the central dividing line, but with two striking exceptions. There is a very cold year, 1829, among the *warm*, and a very warm year, 1834, among the *cold*; and these considerably reduce the difference between the two averages: the comparison or contrast holds best, therefore, *among the years in detail.*

The *full* flexuous-line in fig. 1. shows the variation, from year to year, of the total rain collected by the gauge in each. It is not here as with the temperatures; the amount of *Rain* is balanced, or nearly so, in each nine years. Thus out of 472·93 inches fallen in the whole cycle, 238·60 inches appear to have fallen on the *warm*, and 234·33 inches on the *cold* side, making the annual averages respectively 26·51 and 26·04 inches, nearly; which is about *an inch more* on the whole *per annum* than is found to fall near London—the level being at the ground, in both. If we now look through the *curve* (I beg pardon of mathematicians for applying the term to such a line,) we shall probably be first struck with an extreme of dryness (1826) followed by an extreme of wetness (1828) on the *warm* side; then, with a gradation from *very* wet (again following very dry) in 1830, to *very* dry in 1835; and this again mounting by steps to extreme wet again in 1839. In fact, ten years, from 1830 to 1839, show a gradual decrease and again an increase of rain, protracted through the half-cycle, while eight years from 1840 to 1829 (passing thus back to make the cycle) show repeated and more extended oscillations, performed in shorter times; yet with results so nearly the same, that the first set of years, here specified, show an average rain of 26·36 inches, while the second set average 26·16 inches. Again, on comparing rain with temperature, we find 1826 in the extreme at once of *warmth* and *dryness*, and 1839 in those of *wet* and *coldness**: but 1828 (in the extreme of wetness) is equal in *heat* to the dry 1826; and 1829 is both *dry* and very *cold*. The quantity of rain, therefore, is not regulated by the *temperature* of the year: we may get it with *heat*, brought by winds highly vaporised from the tropic; or with

[* See the paper "On the Summer of 1839," page 15ª.]

1.

Cycle of Yearly Rain and Mean Temp^re at Ackworth Lat. 53° 39' N.



J. Henshall Sculp.

cold, from the condensation effected by the approach of northern air to our own atmosphere, previously charged with vapour to the full; and the dryness of 1829, with so much of *cold*, may have been the result of the great deposition of rain in the previous season. The only rule, then, that prevails throughout, seems to be *compensation*; a wet year against a dry one, &c., and so of whole runs of seasons; and we must examine the *winds* for the cause.

This I have done in my paper before the Royal Society alluded to above; but the subject, complicated as it is with the moon's intricate orbit, and her varying influence on the currents that sweep these islands, is much too extended for the compass of this paper*. We have to do, here, not so much with causes as with the effects they produce; a knowledge of which must necessarily go before the other. I shall proceed therefore at once, from the review of the rain and temperature of *whole years*, to an analysis of the distribution of these through the *several months* of the year; which will let us probably into the secret of the difference, *under equal quantities of rain*, of the warm from the cold side of the cycle; as regards the most important of its effects, *the fruitful or unfruitful character of our seasons*.

The full flexuous line in fig. 2. (Plate V.) presents the monthly rain, in its total amounts under each month, for the *nine years* 1824 to 1832, or warm period; the dotted curve, the same for the *nine years* 1833 to 1841, or *cold* period of the cycle. I shall compare these with the temperature in another figure; the present object is to show the remarkably different *distribution* of the like *quantity* of rain, in each. The warm period, then, shows *December* barely dry, its rain being three-tenths of an inch below the mean betwixt the driest and wettest months, which is at 19·59 inches. *January*, *February* and *March* are in the extreme of *dryness*. In *April* of this period, the rain suddenly mounts up to a point full three inches above the mean, and descends again three and a half inches below it, to make us a fine *May*. The months of *June* and *July*, though high in the scale of rain, have the advantage (the former considerably) in dryness of those of like denomination in the cold period. But in *August* and *September* we see the case reversed; the amounts of rain in the warm *exceeding* (by about five inches in each) those of the cold period. *October* is wet in both nearly to the same degree; and by the by, I may here observe, that the rains in this month fall mostly by night; verifying a remark I heard many years since from a friend, that "there are always twenty fine *days* in October." *November*, though wet, is drier on the warm side by a quantity exceeding two and a half inches on the cycle: of *December* we have treated as regards this side—to turn now to the other.

[* See the papers referred to page 33, note; also page 41.]

In the cold period, *Deeember* is very dry; which dryness is ominous of wet in *January, February* and *March*; carrying the rain in these to an excess over the former period of four and a half, seven and three quarters, and three inches, respectively. To these succeeds *a dry April* (perhaps the worst feature for agriculture of the whole), the rain falling short by *nine inches* of the former total. This want is hardly supplied by the more copious rains in *June*; for they come usually accompanied by far too much of *wind*, in the summer of the cold period. *August* and *September* (contrary to what the inexperienced would predict) are much the *drier* months in the cold years: yet the lower temperature and cloudy sky counteract the early ripening of the crops. *November* mounts up, in this period, to the second place for wetness (it has the *first* in the neighbourhood of London) and often completes the destruction of what the drier weather of the preceding months had come too late to enable us to save. I shall not need (were I more capable of the office) to point out to the experienced farmer the advantages and disadvantages *to him* of these different arrangements. They are the work of the all-wise Creator; ordered no doubt for the best *on the great scale of things*. It is for us, instead of vainly wishing them otherwise, to turn to the best account (which we surely may, with the helps derived from accurate observation and a full record,) the opportunities they present. The results in figures, from which the curves I have hitherto treated were laid down, will be found in Tables in the following pages.

Fig. 3. (Plate V.) gives the rain under each month, *for the whole eighteen years*, represented by a full line; in connexion with the average temperature of each month for the like series of years, in a *curve* (which may be so called without a qualifying remark) corresponding as nearly as those in my 'Climate of London*' with *the curve of the sun's declination*; which I have placed, in a fine dotted line, in connexion with both. This diagram is instructive, as regards the average increase of our rains as the sun approaches us from the south, and their falling off in quantity as he recedes towards the tropic of the other hemisphere: and it serves well for a test *of the completeness of the account of temperature through the eyele*; the solar and the thermometric curve agreeing in form, with the like exceptions, as about London; of an accelerated rise in the spring and a retarded fall in the autumn; which I have shown in my work above mentioned to be the necessary conditions of our annual variation. The results in figures belonging to this beautiful curve will be found in the Tables further on.

In figures 4, 5, 6 and 7, (Plate VI.) I have given the rain and temperature *of the*

[* Second Edition, vol. i. "Of the Temperature," p. 11 to p. 58: Fig. 2, and Fig. 11 to 15.]

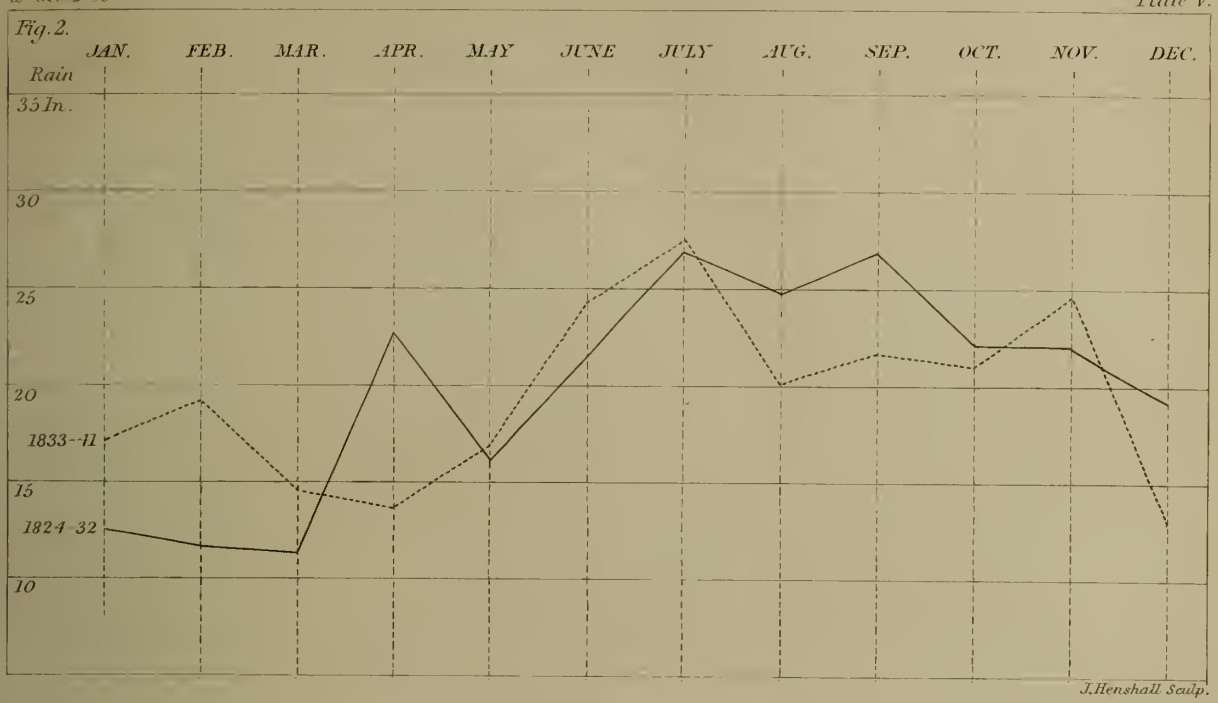


Fig. 2.
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEP.
OCT.
NOV.
DEC.
Rain
35 In.
30
25
20
1833-41
15
1824-32
10
J. Henshall Sculp.

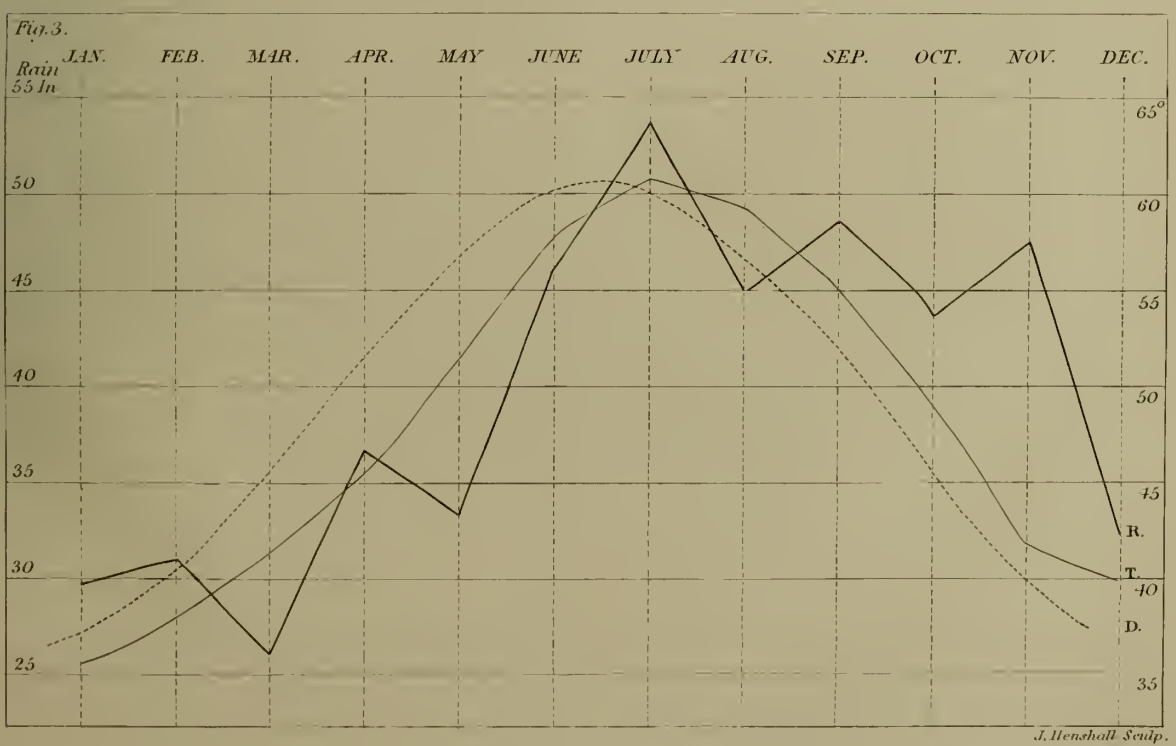
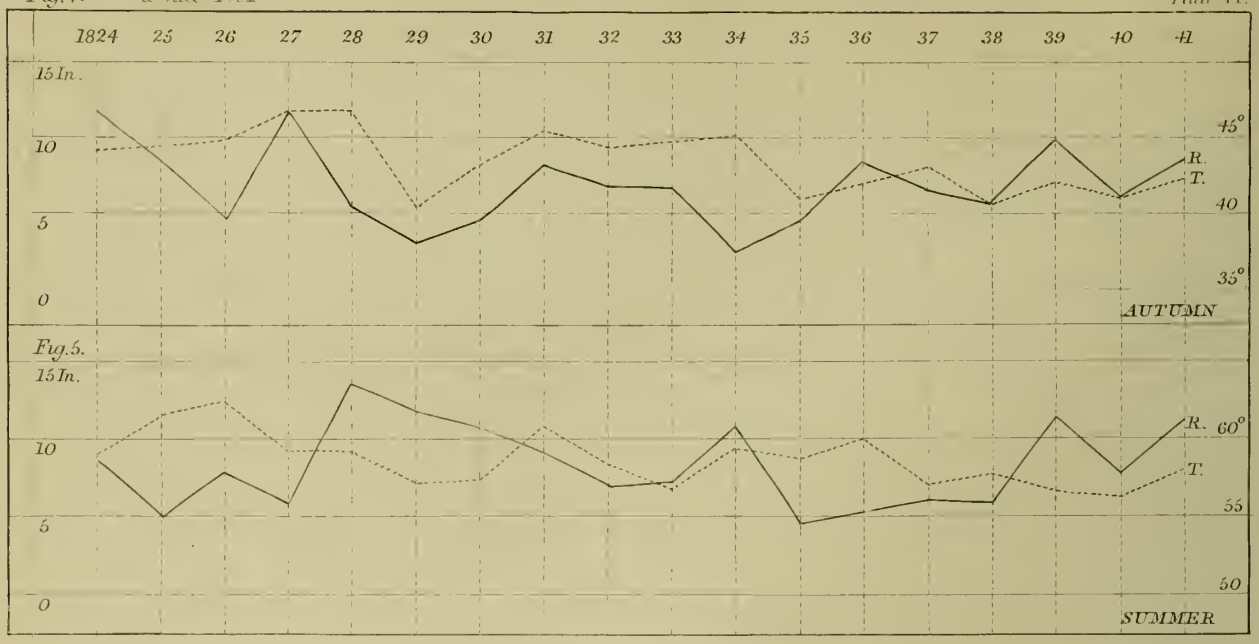
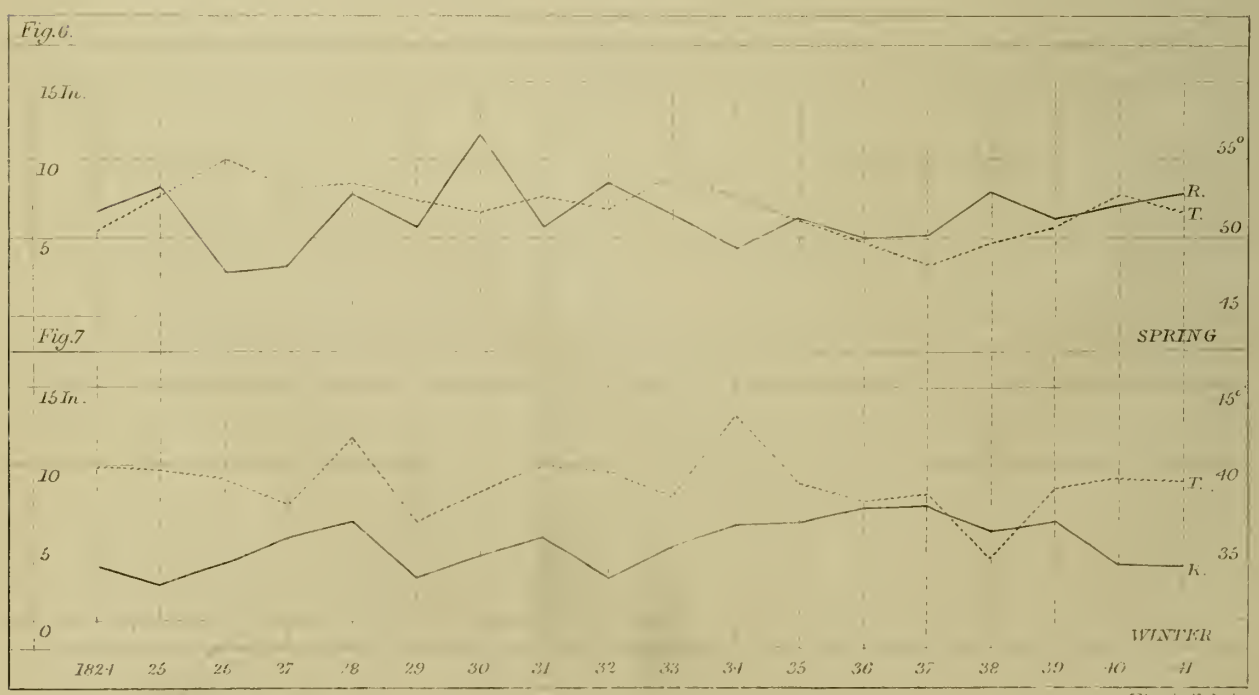


Fig. 3.
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEP.
OCT.
NOV.
DEC.
Rain
55 In
50
45
40
35
30
25
65°
60
55
50
45
40
35
R.
T.
D.
J. Henshall Sculp.

Fig.4. to face P.51 Plate VI.





J Henshall Sculp.

four seasons of the year, through the cycle here treated; the numbers belonging to which will be found at the foot of each yearly table, 1824, *Winter* (Jan. to Mar.), &c. at the end (page 59). To have treated these curves in detail would have involved a repetition, in substance, of much of what has been said upon the monthly averages. They will be found upon examination to present many curious gradations and coincidences, in the increase and decrease of the rain and warmth of each season: they show also at a glance the difference, in each, between the warm and cold sides of the cycle: also what summers were particularly warm, and what winters cold; with the nature of the changes, from year to year, throughout, in our most capricious season, *the spring*. As to *rain*, we see at once that the wet of 1824 and 1827 occurred chiefly in the *Autumn*; as did also the drought of 1826 and 1829: that, in the very wet 1828, the rains fell chiefly in the *summer*, so that we had potatoes of a pound and a half in weight, and the crop unequalled in the whole cycle: after which the supply of this season fell off gradually to 1832, was renewed in 1834 and balanced then by a dry *autumn*. In 1839 we see summer and autumn wet; in 1840, both seasons dry: but the most remarkable feature, perhaps, of the whole is the opposition of the curves of winter and spring from 1832 to 1841; the former plainly robbing the latter as it advances in the fore part of the period, and restoring the amount in the latter part. It is to show this peculiarity that I have placed the curves in the order they are found in, the winter one lowest. The rains of the *summers* 1835 to 1838 appear to be given away partly to the autumn, partly to the winter; but it is needless further to anticipate the reader in his remarks.

The yearly *mean heights of the barometer* for the cycle, taken at Ackworth School, are as follows:—

1824.	29·75 inches.	1833.	29·81 inches.
1825.	29·93	1834.	29·98
1826.	29·91	1835.	29·86
1827.	29·84	1836.	29·73
1828.	29·83	1837.	29·80
1829.	29·84	1838.	29·76
1830.	29·81	1839.	29·78
1831.	29·82	1840.	29·84
1832.	29·93	1841.	29·70

Mean of warm period 29·851 inches. Mean of cold period 29·807 inches.
The mean of the whole cycle is 29·829 inches. It appears, then, that the warm

side has the higher average of pressure by 0·44 in. This is consistent with my former observations, as to the greater mean height belonging to *the warmer portion of the year*; which the reader will find in my 'Climate of London,' vol. ii. p. 281, 1st edit.; vol. i. p. 207, 2nd edit. And the same reasons, which there apply to single years, will be found here to suit periods also: for the period from 1815 to 1823 averaged at *Tottenham* 29·788 inches, and that from 1824 to 1832, 29·830 inches; giving thus an excess of pressure to the warm years over the preceding cold ones, of ·042 in. My clock takes in the greatest depressions, and makes the mean lower than it is obtained in the ordinary way: so that these averages of the School and Tottenham, though comparable respectively *at each station*, are not so with each other. As it is, they agree with remarkable nearness in the amount of excess of the warm period.

The *yearly mean temperatures* for the cycle at Ackworth are as follows:—

1824.	48·53°	1833.	48·36°
1825.	49·45	1834.	50·08
1826.	50·25	1835.	47·31
1827.	49·19	1836.	46·52
1828.	50·26	1837.	46·66
1829.	46·64	1838.	45·79
1830.	47·58	1839.	46·69
1831.	49·57	1840.	47·02
1832.	48·44	1841.	47·74

Mean of warm period 48·879°. Mean of cold period 47·374°. Mean of whole cycle 48·126°: excess of first nine years 1·405°.

If we leave out 1829 on one side, and 1834 on the other, and average the remaining years, they come out thus: the first eight years 49·159°, the latter 47·011°: difference 2·148°. Now the nine years from 1815 to 1823 average in the neighbourhood of London 49·065°, and the following nine years, 1824 to 1832, 50·137°: the difference in favour of the warm period being 1·072°. I might go on to prove another warm period, antecedent, and ending with 1814, averaging 49·383°; but the locality (Plaistow) differs, and the observations cannot so properly be brought into the comparison, though they show a small excess. Moreover, the method of computing by whole years and calendar months may bring out inaccurate results in an extended examination. I have proceeded, in my paper now with the Royal Society,

on the solar year and the lunar divisions, which are more agreeable to nature; the cycle of eighteen years depending on these principles*. The reader will find the subject of periods of temperature largely treated in my published work above mentioned; which, *as regards its details*, is not in any degree superseded by the present paper.

The *rain* of the cycle at Ackworth is as follows:—

1824.	30·51 inches.	1833.	25·06 inches.
1825.	24·22	1834.	23·74
1826.	18·74	1835.	21·19
1827.	25·04	1836.	25·21
1828.	32·35	1837.	25·39
1829.	22·85	1838.	25·02
1830.	31·58	1839.	33·16
1831.	28·37	1840.	24·75
1832.	24·94	1841.	30·81

Rain of the warm years 238·60 inches; of the cold years 234·33 inches. Rain of the whole cycle 472·93, or *per annum* 26·27 inches; the warm side averaging 26·51 inches, the cold 26·037 inches. I have found cause, on examining into past periods, to conclude that the small excess of rain here found on the warm side is not a constant result; but that the *cold* may sometimes be the wetter. The main point affecting our harvests appears to be the different distribution of the rain *within the year* in each period, to which we now proceed: but first of the whole cycle.

The following are *the total amounts of rain* for *each month* of the year, through the cycle from 1824 to 1841; to which are annexed the monthly averages of heat, or *the mean temperature of each month* for these eighteen years. The reader will see, on comparing the latter with the curve of the sun's declination (see Plate V. fig. 3.), that the warmth and coldness, thus averaged on a cycle, follow pretty strictly (though at some distance, as I have shown in the 'Climate of London,') *the proportionate height of the sun* through the seasons; ascending thus to July and descending again to January: the rain itself being somewhat similarly affected, but with a diminution of quantity in the spring months, and an addition in the autumnal, *depending on other causes.* I

[* This paper is given at page 43ª.]

have treated these also in my work above mentioned, under the head of "Rain," to which I must here refer.

	Rain.	Mean Temp.
January	29·88 inches.	35·734°
February	31·16	38·176
March	25·97	41·600
April	36·49	45·852
May	32·99	51·699
June	45·96	57·921
July	54·52	60·717
August	44·81	59·513
September	48·65	54·947
October	43·46	49·466
November	46·96	41·786
December	32·08	39·413
Total	472·93	Mean of year . . 48·069

All which the reader is requested to compare with the curves.

Now, for the distribution to the several months, in the *warm* and in the *cold* period, the following are the results in figures :—

	1824–1832.	1833–1841.
January	12·67 inches.	17·21 inches.
February	11·75	19·41
March	11·51	14·46
April	22·75	13·74
May	16·11	16·88
June	21·58	24·38
July	26·85	27·67
August	24·77	20·04
September	26·98	21·67
October	22·17	21·29
November	22·17	24·79
December	19·29	12·79
Total in the warm years	238·60	234·33 Total in the cold years.

Of these quantities we have, on the *warm* side, for

January, February, March	35·93 inches.
April, May, June	60·44
July, August, September	78·60
October, November, December	63·63

And on the *cold* side, for

January, February, March	51·08 inches.
April, May, June	55·00
July, August, September	69·38
October, November, December	58·87

The reader will be pleased to compare the numbers with the curves in Plate V. fig. 2. I have already made such remarks on these as may suffice for his help.

On bringing into comparison the curve of the rain-cycle, 1824 to 1841, with that for the preceding cycle, 1806 to 1823, in the neighbourhood of London, the following differences appear. At *London*, January, in the whole eighteen years, has 10 inches *more* rain; March, 5 inches *more*; April, 7 inches *less*; May, 6 inches *more*; June, 18 inches *less*; and July about 10 inches; August and September have respectively 14 inches and 20 inches *less* at London. The two following months nearly agree in amount with Ackworth (as does February), but December was 20 inches drier at London. With these differences, the two curves still show the common feature of a general accordance with the sun's declination *through the fore-part of the year*: but this is done away in the London curve, afterwards, by the dryness of August and the extreme wetness of November and December. Were the several cycles of amounts of rain, which we now possess, averaged for each year upon nine successive years, and thus reduced to easy curves (as I have done with the barometrical heights), these would undoubtedly present some striking features, leading to the true theory of our rains in Britain; but this is more than I can here undertake to produce.

The following are observations made, with one of my gauges, by my friend Thos. Fowler, Esq., at Tottenham, for seven years past, placed in comparison with those of the school at Ackworth.

	in.		in.
1835. year's rain at Ackworth	21·19	At Tottenham	24·43
1836.	25·21		29·76
1837.	25·39		20·61
1838.	25·02		23·13
1839.	33·16		28·64
1840.	24·75		21·79
1841	30·81		31·34
Total in seven years . . .	185·53		179·70

The annual averages thus obtained are for Ackworth 26·50, and for Tottenham 25·67 inches. If we compare the amount, throughout, we shall see the *wet* years coinciding, except in 1836; the *dry* years set against *mean* ones, each way; and the total amounts affording each an average very near to that of the station itself: the two mean years, 1836 and 1837, at Ackworth, balance the wettest and the driest that occur at Tottenham. The whole confirms a remark I have often made in passing to and fro, that we seldom see the Trent and the Thames full with rains, together; their estuaries communicating with different portions of the surrounding sea, and the respective districts that feed their springs requiring somewhat different winds to furnish them with vapour.

After acknowledging my obligations to the present and former Superintendents, and the successive Clerks, of the Institution at Ackworth, it is proper I should caution my reader against *expecting too much* from the information here presented to him. Should he look for the *same mean temperature*, and the *same amount of rain*, in each returning year of the coming cycle, as are found recorded of a corresponding one in the past, he will probably meet with frequent disappointments; and this more especially in a locality somewhat different. We are yet far from being able to predict seasons in meteorology with the like certainty of date as the astronomer does the coming phænomena of the heavens; and it is even possible that, from the very nature of the causes concerned, we may never arrive at this. The judicious observer, finding certain facts fully ascertained and clearly noted for him, *will know how to make use of these for himself*; and by watching their occurrence in detail, making notes as he proceeds, will endeavour to feel his own way towards the future; independently of empirical and fallacious *predictions*. This is the kind of service which I expect my present labour to render to the country; besides gratifying a reasonable curiosity as to the past. We do not expect to become skilful in other arts without a due share

of study and practice; but we seem to forget this self-evident truth, when we take up that of foretelling the weather. The facts here detailed cannot fail to be useful to such as will be at the trouble to examine and compare them, though the inferences they may draw from them should differ. And admitting only that, in the course of years here treated, we experience in succession the various degrees of warmth and coldness, of rain and dryness incident to our climate, it must needs help the farmer, the market-gardener, the planter or nurseryman, the grazier, the sheep-master, to have before him such an approximation to the times and order of their occurrence.

A comparison in detail of the warmth and rain of successive seasons with *the yield and quality of the harvest* belonging to them, would have formed, perhaps, a desirable appendage to the *meteorology* of my paper. But I have not before me the materials for this: and to have waited to collect them would have caused me much delay in publishing it, which I have reasons for wishing to avoid. The subject, moreover, viewed in this light, is a very copious one. It is not alone the grower of *corn* that is interested in a warm or a cold, a dry or a wet season; there are a variety of rural occupations, and of trades and manufactures dependent on them, equally concerned in these. And we have the satisfaction of thinking, that these are severally the best judges of their own needs and occasions; that each will be best able to avail himself to purpose of the meteorological facts, established for him by the labours of men of science.

There is a class of persons, however, to whom the paper may be immediately acceptable, and possibly also useful in regulating their future plans. The poor invalid may be soothed, and those of delicate constitutions encouraged, by the immediate prospect of a nine years' run of seasons having, with little exception, *the higher temperature of our climate.* It may be the means of inducing these to make trial at least of one or two of these, before they resort to other skies more favoured by natural position, but extending over countries far less desirable as residences to a truly British mind. And medical gentlemen, when they have read and considered what is here laid before them, may find arguments in it to strengthen such a conclusion.

At the present moment, when we are debating with earnestness the question of our corn-importation, and while some are looking for an absolute scarcity, it cannot be uninteresting to public men to know what, in a scientific point of view, are the bearings of the question of *climate* and *seasons* on this other and more tangible one. That they are on the whole highly favourable, will, I hope, be an announcement giving pleasure to both sides: yet here, also, I must put in a word of caution.

Plenty, I have shown, as regards our grain-crops, is dependent partly on a sufficiency of *warmth on the whole year*, partly on *rains administered in due season*. But we *may* have a season or two to go through, in which, though our personal comfort may be increased by dry and hot weather, the crops may not be so well fed, or the sheep so well fatted, as we would have them. But we abound in resources (through the goodness of God to his creatures), and may cheerfully proceed to do our duty and make use of them, in reliance on the Divine Providence; happy also if, through His grace, we have learned to feel for the distress of others, and do for them *in all respects* that which we would they in like circumstances should do for ourselves. This is the great lesson which many of us have yet to learn, more perfectly, to become more safely *proud* (in a good sense of the term) of the name of *Christian*. My countrymen will, I am sure, not be offended by this hint, from one now nearly of an age to be released from all public engagements; but who finding the matter before him, and apprehending a public service in it, could not well forbear the present.

Tottenham, Middlesex,
March 31, 1842.

[The reprint of the work entitled "A Cycle of Eighteen Years in the Seasons of Britain," etc. terminates with the Tables which occupy the next six pages, ending with page 64.]

Tables of the Barometer, Temperature and Rain, with Notes on the Seasons.

Mean height of the Barometer, Mean Temperature and depth of Rain in each month, at Ackworth, Yorkshire, through a Cycle of Eighteen Years.

	1824.			1825.			1826.		
	in.	°	in.	in.	°	in.	in.	°	in.
January	29·90	39·53	0·60	30·09	39·03	0·80	30·00	32·32	1·05
February	29·74	39·36	0·89	30·04	39·14	0·34	29·78	42·84	2·23
March	29·71	40·39	1·82	30·08	40·80	1·28	29·92	41·82	0·45
April	29·79	44·89	1·22	29·94	47·22	4·56	30·02	49·95	1·67
May	29·91	50·52	1·10	29·92	52·11	2·52	30·03	51·19	0·79
June	29·84	56·28	4·59	29·89	58·17	1·53	30·20	63·96	0·37
July	29·91	62·40	0·43	30·09	62·80	0·76	29·91	64·72	1·65
August	29·86	59·60	1·67	29·84	61·58	3·28	29·89	64·90	1·00
September	29·76	56·60	6·36	29·83	59·81	0·85	29·85	56·90	5·10
October	29·54	48·49	6·07	29·81	52·32	2·48	29·75	51·84	1·31
November	29·45	43·75	2·25	29·87	40·52	2·86	29·78	40·76	1·87
December	29·66	40·54	3·51	29·71	39·92	2·96	29·80	41·76	1·25
Whole year	29·75	48·53	30·51	29·93	49·45	24·22	29·91	50·25	18·74
Winter (Jan. to Mar.)		39·76	3·31		39·66	2·42		38·99	3·73
Spring (Apr. to June)		50·56	6·91		52·50	8·61		55·03	2·83
Summer (July to Sept.)		59·20	8·46		61·39	4·89		62·17	7·75
Autumn (Oct. to Dec.)		44·26	11·83		44·25	8·30		44·79	4·43

Notes. 1824.—The driest *January* and *July*, and the wettest *September* and *October*, of the cycle of eighteen years: compare these months in 1825, 1826, 1827, 1830, 1833, 1835, 1841. The wettest *December*: compare the remaining years.

1825.—The wettest *April* of the cycle: compare 1828, 1830, 1833. *September* the driest but one: compare 1832. The driest *February* but one: compare 1832.

1826.—The driest *year* of the cycle, and making with 1828 the two of highest temperature: it has by far the hottest summer: compare July to September in the remainder. The driest *June* in the cycle, and the warmest: compare 1827, 1828, 1837. The *January* among the coldest: compare forward.

Mean height of the Barometer, Mean Temperature and depth of Rain in each month, at Ackworth, Yorkshire, through a Cycle of Eighteen Years.

	1827.			1828.			1829.		
	in.	°	in.	in.	°	in.	in.	°	in.
January	29·78	35·05	1·58	29·87	40·11	3·51	29·82	32·11	0·65
February	30·04	34·53	0·95	29·77	40·97	1·11	30·02	38·52	1·79
March	29·55	42·98	2·85	29·83	44·09	1·58	29·85	38·81	0·32
April	29·92	48·13	0·78	29·72	46·93	4·01	29·47	44·22	2·94
May	29·70	52·78	1·67	29·84	53·38	1·82	30·00	53·76	0·36
June	29·85	58·52	0·66	29·93	60·10	1·27	29·95	58·47	2·08
July	30·02	62·71	1·39	29·64	61·44	9·48	29·71	61·45	3·00
August	29·97	58·39	2·79	29·82	59·74	1·28	29·75	57·68	5·19
September	29·95	56·83	1·76	29·92	56·66	2·76	29·68	52·41	3·27
October	29·72	53·48	5·81	30·01	50·00	0·92	29·91	47·32	1·21
November	29·94	43·56	2·56	29·81	45·00	2·77	29·93	40·99	1·27
December	29·69	43·27	2·24	29·82	44·67	1·84	30·00	33·96	0·77
Whole year	29·84	49·19	25·04	29·83	50·26	32·35	29·84	46·64	22·85
Winter (Jan. to Mar.)		37·52	5·38		41·72	6·20		36·48	2·76
Spring (Apr. to June)		53·14	3·11		53·47	7·10		52·15	5·38
Summer (July to Sept.)		59·31	5·94		58·95	13·52		57·18	11·46
Autumn (Oct. to Dec.)		46·77	10·61		46·56	5·53		40·76	3·25

Notes. 1827.—The coldest *February* but one in the cycle: compare 1830, 1836, 1838, 1841; and *March* among the wettest: compare 1836, 1839. *April* the driest but one: compare 1839. *June* the driest but one: compare 1826. *July* among the warmest: compare back and forward. *September* very warm and dry. *October*, of the warmest and wettest: compare the rest. This is the middle year of five in succession having the barometrical average *above the mean of the cycle*: compare 1837 in Note.

1828.—The wettest *year* but one, and of the two warmest: compare 1826, also 1834: the *July* the wettest *month* in the cycle: compare 1827, 1834. Note, also, the gradation from year to year in the mean temperature of summer (first rising and then falling) through the space from 1824 to 1829. In the spring temperature, with a single exception, the like rise and fall. *April* was among the wettest: compare 1825. See Plate VI. figs. 5 and 6.

1829. A cold year, and of the driest. *January* among the coldest of the cycle; and of the driest. The driest *March* but one: compare 1840: and among the coldest: compare 1833, 1836, 1837, 1839, 1840. *May* the driest of the series: compare 1826, 1833, 1834, 1836, 1839. *August* the wettest of the series: compare 1825, 1832, 1833. *September* wet. *December* the coldest in the set, and of the driest: compare 1830, 1835, 1839, 1840.

Mean height of the Barometer, Mean Temperature and depth of Rain in each month, at Ackworth, Yorkshire, through a Cycle of Eighteen Years.

	1830.			1831.			1832.		
	in.	°	in.	in.	°	in.	in.	°	in.
January	29·98	32·00	0·71	29·84	34·58	2·56	29·92	37·11	1·21
February	29·81	36·32	3·12	29·75	40·43	1·08	30·06	38·12	0·24
March	29·97	46·24	0·42	29·81	44·63	1·62	29·81	42·98	1·17
April	29·64	48·50	3·44	29·70	48·27	1·60	30·01	46·35	2·53
May	29·80	51·10	3·75	29·92	51·53	2·18	29·92	51·05	1·92
June	29·74	55·00	4·88	29·87	58·42	2·11	29·82	58·70	4·09
July	29·84	61·55	4·37	29·92	61·66	4·20	30·03	59·34	1·57
August	29·78	56·90	2·36	29·90	62·29	2·54	29·80	59·11	4·66
September	29·65	53·68	3·79	29·87	56·22	2·40	30·05	56·18	0·69
October	30·15	51·22	0·32	29·74	53·93	2·58	29·94	51·22	1·47
November	29·72	43·88	2·21	29·79	40·53	3·60	29·99	40·17	2·78
December	29·62	34·56	2·21	29·72	42·33	1·90	29·86	40·94	2·61
Whole year	29·81	47·58	31·58	29·82	49·57	28·37	29·93	48·44	24·94
Winter (Jan. to Mar.)		38·19	4·25		39·88	5·26		39·40	2·62
Spring (Apr. to June)		51·53	11·07		52·74	5·89		52·03	8·54
Summer (July to Sept.)		57·38	10·52		60·06	9·14		58·21	6·92
Autumn (Oct. to Dec.)		43·22	4·74		45·59	8·08		44·11	6·86

Notes. 1830.—This year stands third in wetness, and shows a low temperature. *January* and *March* are again very dry, and the *February* between of the wettest! *April* to *July*, and *September*, afterwards, all show an excess of rain. The curious equality of rain, in the winter and autumn moderate, and in the other two seasons as excessive, is also worth notice. The temperature is again low, and that of *January* and *March* frosty.

1831.—The rain now falls off again, while the temperature rises. The *July* and *November* are wet, the latter in the extreme *for this side of the cycle.* The month of *August* presents a great advance in warmth upon the preceding years, and the whole year has a temperature above the mean.

1832.—This year closes the warmer series of the cycle. With a still further approach to dryness, reducing the rain to a quantity below the average, we have also a reduction of the mean temperature. The winter is of the driest, exceeded only by 1825, and *February* has the least wet of any month but one in the *cycle.* The month of *June* is of the wettest, and the rain of *August* exceeded only by the same month in 1829.

Mean height of the Barometer, Mean Temperature and depth of Rain in each month, at Ackworth, Yorkshire, through a Cycle of Eighteen Years.

	1833.			1834.			1835.		
	in.	°	in.	in.	°	in.	in.	°	in.
January	30·21	33·66	0·76	29·72	43·54	3·70	29·98	34·52	1·77
February	29·41	41·70	2·76	30·02	42·06	0·57	29·60	40·79	2·69
March	29·88	38·45	1·34	30·11	44·25	1·49	29·85	41·22	1·67
April	29·72	46·07	2·78	30·15	45·17	1·83	30·06	45·20	1·06
May	30·05	57·93	0·54	29·99	53·80	0·66	29·81	50·35	2·60
June	29·70	58·03	3·11	29·89	58·77	1·99	29·97	57·15	2·28
July	29·94	60·42	1·09	29·91	62·01	7·03	29·96	60·53	0·63
August	29·87	56·30	4·50	29·83	60·20	2·09	29·92	61·52	1·55
September	29·86	53·03	1·49	30·04	55·82	1·83	29·60	53·95	2·33
October	29·74	48·73	2·76	29·93	48·92	0·26	29·66	45·18	2·47
November	29·80	42·93	1·32	29·92	45·05	1·16	29·84	41·70	2·02
December	29·53	43·11	2·61	30·23	41·42	1·13	30·11	35·68	0·12
Whole year	29·81	48·36	25·06	29·98	50·08	23·74	29·86	47·31	21·19
Winter (Jan. to Mar.)		37·94	4·86		43·28	5·76		38·84	6·13
Spring (Apr. to June)		54·01	6·43		52·58	4·48		50·90	5·94
Summer (July to Sept.)		56·75	7·08		59·34	10·95		58·67	4·51
Autumn (Oct. to Dec.)		44·92	6·69		45·13	2·55		40·85	4·61

Notes. 1833.—This is a year of mean temperature, and having an average amount of rain. *January* of the driest and coldest: compare 1824, 1825, 1826, 1829, 1830, 1838. *February* wet: compare 1830, 1835, 1836, 1837, 1838. *March* dry and cold, and *April* wet. *May* of the driest, and the *warmest* of the series, but *variable*: thermometer at 80° and at 34°. *June* wet, *July* of the driest, and *August* wet: compare with the rest.

1834.—A warm year, in the *cold* period of nine; as 1829 was cold amidst the *warm* years. It has the highest barometer, and continues the tendency toward the *dry* extreme; its rains fell chiefly in *January*—(the wettest of the series, compare 1831 and 1837) and in July, the wettest, save in 1828, and *warm*. The *May* was dry, like the last, and the *October* the driest of the series.

1835.—A *year* of extreme *dryness*, second only to 1826, but the reverse of that in temperature, being of the coldest. *January* and *December* cold; and the latter, the driest *month* in the *whole cycle* of eighteen years: at this point the gradual tendency to drought ceases, and the *three* following years have each a mean amount of rain. The rain of this year falling so much in May and June, with July and August dry and warm, it may be thought to have been favourable to the crops, the general drought notwithstanding.

Mean height of the Barometer, Mean Temperature and depth of Rain in each month, at Ackworth, Yorkshire, through a Cycle of Eighteen Years.

	1836.			1837.			1838.		
	in.	°	in.	in.	°	in.	in.	°	in.
January	29·74	36·48	1·65	29·81	36·54	3·28	29·86	29·45	1·00
February	29·66	36·19	2·02	29·76	41·73	3·16	29·55	30·25	3·35
March	29·38	39·75	3·39	29·88	35·79	0·99	29·70	41·39	1·40
April	29·75	41·90	1·48	29·51	39·65	2·00	29·67	42·78	1·58
May	30·17	49·20	0·68	29·82	48·08	1·62	29·84	48·17	3·38
June	29·76	58·86	2·72	29·90	56·96	1·51	29·76	57·54	2·61
July	29·81	59·05	2·33	29·84	60·58	2·64	29·85	60·25	1·82
August	29·93	56·87	0·69	29·82	57·60	1·39	29·73	59·24	2·59
September	29·75	53·15	2·10	29·82	53·03	2·13	29·92	53·00	1·41
October	29·70	47·50	1·71	29·94	49·29	2·08	29·85	50·10	3·31
November	29·45	39·80	4·67	29·68	40·88	1·65	29·47	39·20	2·01
December	29·66	39·54	1·77	29·82	39·74	2·94	29·95	38·08	0·56
Whole year	29·73	46·52	25·21	29·80	46·66	25·39	29·76	45·79	25·02
Winter (Jan. to Mar.)		37·44	7·06		38·02	7·43		33·69	5·75
Spring (Apr. to June)		49·99	4·88		48·23	5·13		49·49	7·57
Summer (July to Sept.)		59·69	5·12		57·07	6·16		57·49	5·82
Autumn (Oct. to Dec.)		42·28	8·15		43·30	6·67		40·85	5·88

Notes. 1836.—A *cold* year, the rain an average: a wet *February* and very wet *March*; with *April* and *May* dry: compare 1826, 1827, 1830, 1833, 1837, 1838, &c. The low temperature is pretty uniform through the twelve months. The *August* has the least rain of any month in the cycle of that denomination, and *November* the most: compare 1826, 1831, 1839, 1840.

1837.—The mean temperature and rain nearly as in last year. *January* and *February* in the wet extreme; *March* of the driest, and *April* reasonably wet. *December* the wettest of any in the cold years. The middle year of five *having the barometrical average below the mean of the cycle.*

1838.—The coldest *year* of the whole cycle of eighteen, chiefly due to the low temperature of the winter months: the third year in succession with rain about the average. *December* as dry as the preceding one was wet: *February*, *May* and *October* show the largest amount of rain. By *rain* the reader must, of course, sometimes understand the product of the gauge in *melted snow*: and the lying of this over, unmelted, may sometimes have thrown some excess upon the measure of the month following.

Mean height of the Barometer, Mean Temperature and depth of Rain in each month, at Ackworth, Yorkshire, through a Cycle of Eighteen Years.

	1839.			1840.			1841.		
	in.	°	in.	in.	°	in.	in.	°	in.
January	29·92	36·82	1·21	29·62	36·99	1·92	29·74	33·47	1·92
February	29·46	39·35	1·94	29·86	38·38	1·89	29·74	36·50	1·03
March	29·73	38·70	3·20	30·23	39·82	0·11	29·75	46·70	0·89
April	30·09	44·27	0·52	30·05	49·85	1·51	29·76	46·00	0·98
May	29·95	50·00	0·51	29·83	51·35	3·67	29·76	54·28	3·22
June	29·82	56·00	4·72	29·88	57·26	1·99	29·83	54·40	3·45
July	29·76	58·00	5·23	29·74	57·00	2·71	29·71	57·00	4·19
August	29·91	57·47	2·57	29·79	60·50	2·04	29·75	61·35	2·62
September	29·53	54·00	3·40	29·64	51·50	2·87	29·69	56·28	4·11
October	30·00	47·70	3·54	29·90	45·65	0·92	29·48	47·50	4·24
November	29·63	42·00	4·50	29·50	41·50	4·61	29·63	39·94	2·85
December	29·64	36·00	1·82	30·09	34·48	0·51	29·53	39·43	1·33
Whole year	29·78	46·69	33·16	29·84	47·02	24·75	29·70	47·74	30·81
Winter (Jan. to Mar.)		38·29	6·35		38·39	3·92		38·89	3·84
Spring (Apr. to June)		50·09	5·75		52·82	7·17		51·56	7·65
Summer (July to Sept.)		56·49	11·20		56·33	7·62		58·21	10·92
Autumn (Oct. to Dec.)		41·90	9·86		40·54	6·04		42·29	8·42

Notes. 1839.—The wettest *year* of the whole cycle, with the lowest barometer, and also cold in the extreme; but the average temperature has risen nearly a degree. If we compare the rain assigned to the "Summer," with that of the same season in the *warm* 1828, and the *cold* 1829, we shall see that the wetness of a summer is not dependent on the temperature, but springs from other causes. The *April* and *May* of this wet and cold year are the poorest in rain of any of these (taken together) in the whole cycle.

1840.—The mean temperature still a little better, the rain considerably below average: *March*, showing only 0·11 in., should seem the driest *month* of the whole *cycle*, but that *snow*, fallen in the latter days of it, may have caused some part of the measure to go to the account of *April*; which is sufficiently meagre of rain in itself. The wettest *May* but one, and the like of *November*: compare 1830, 1836.

1841.—The mean temperature still advancing; but still exceeded by all the warm-period years, 1829 excepted: the rain up again to the wet extreme. *March* was pretty dry, as were the colder months generally: the rain, as to its excess, belongs to the warmer six months from *May* to *October*. The temperature of *July* in this year falls below that of the same month in every year of the warm period, save 1832: and *September* and *October*, taken together, are the wettest since 1824. Thus we complete the *cycle*.

In July 1842, subsequently to the appearance of the work now reprinted, the author published on a folio sheet a coloured Chart or Diagram, identical in subject and construction with that illustrating his communication to the British Association of the preceding month, as already noticed. This is entitled "A Cycle of Eighteen Years in the Seasons of Britain;" the explanation appended to it consists of the substance of the communication alluded to, as given in the Report of the Association, and the table of the proportions of the winds is also the same.

The Transactions of the Sections, in the Report of the Fifteenth Meeting of the British Association, which took place at Cambridge in June 1845, contain, at p. 25, the following abstract of another communication by Mr. Howard, under the title "On a Lunar Meteorological Cycle."

"Mr. Howard reports that the facts of the last two years compel him to modify his anticipations as to the extent to which the lunar cycle will enable him or others to become 'weather prophets.' But he says the deferred heat (to be expected from the corresponding period of the cycle in 1825 to 1828) may prove to be only defeated cold; and the absence of so great an elevation of the mean temperature now, may spare us a repetition for many seasons to come of the cold which occurred between the years 1835 and 1840. To show, however, that causes exist for these periodical alternations of warmth and cold, much more extended in their effects than any which are peculiar to our own climate, he procceds in detail to place in review together the annual mean temperature for eighteen years (ending with 1823) at Geneva and London. It will be seen that the two cities differ little in their climatic or *annual mean*; the more southern latitude of the former being counteracted by its greater elevation above the sea."

The table alluded to of the annual mean temperatures from 1806 to 1823 succeeds the above abstract, and the whole is illustrated by a "*Comparison of the Variation of the Annual Mean Temperature at London, with that at Geneva, through a Cycle of Eighteen Years*," in the form of a coloured diagram, Plate IV. of the Report.

In the "Notes, Historical and Illustrative" of the Barometrographia itself, for the years 1832 and 1833, the author has returned to the subject "of a period of eighteen years as coming nearest to a cycle in Meteorology;" the former year making the eighteenth of those the atmospheric phænomena of which are exhibited in that work, and the latter being the first on the *cold* side of the cycle 1824–1841.

He summarily reviews the variations of the Barometer during the period 1815–

1832, comparing them with the contemporaneous states of the weather, and annexes a table presenting at one view the principal results of this cycle, "viz. the *maximum*, *minimum*, and *mean* for each year of the BAROMETER, with its yearly *range*; the *extremes* and *mean* of the THERMOMETER; the depth of RAIN, and the number of days on which rain or snow fell in the year." The peculiar character of the two years 1832 and 1833 is also alluded to as being conspicuous in the diagram published in 1842, above described.

TABLES OF THE TEMPERATURE AND RAIN AT ACKWORTH FOR THE PERIOD OF NINE YEARS FROM 1842 TO 1851; BEING THE FIRST HALF OF THE CYCLE SUCCEEDING THAT BEFORE INVESTIGATED*.

	1842.				1843.			
	Max.	Min.	Mean.	Rain.	Max.	Min.	Mean.	Rain.
	°	°	°	in.	°	°	°	in.
January	44	10	32·36	1·83	55	17	38·60	1·26
February.....	56	26	39·70	0·55	50	13	34·25	3·72
March.....	60	29	43·75	3·20	64	25	41·75	0·91
April	67	28	45·59	0·20	65	24	46·95	1·82
May	66	35	52·00	1·92	65	32	50·06	2·50
June	76	41	59·57	1·70	71	41	55·08	2·12
July	75	39	58·00	3·82	78	42	59·69	3·89
August	83	43	62·50	1·64	78	43	59·73	3·59
September	72	36	55·40	2·76	76	37	58·63	1·05
October	63	25	45·40	1·16	66	26	44·75	3·86
November	58	29	41·50	3·28	56	22	41·63	2·21
December	60	28	45·00	0·74	58	24	43·50	0·27
Year	83	10	48·39	22·83	78	13	47·88	27·20
	1844.				1845.			
January	54	17	37·77	1·32	53	7	35·15	0·76
February.....	50	11	33·70	2·31	48	17	32·00	0·65
March.....	62	23	40·06	2·41	60	12	36·25	1·80
April	68	28	49·10	0·22	66	25	46·17	1·46
May	71	30	50·79	0·22	66	37	49·32	2·68
June	79	36	57·95	1·70	78	44	58·60	2·76
July	82	41	58·74	2·48	74	42	57·62	3·79
August	72	38	55·79	2·00	72	44	56·73	4·41
September	78	32	54·85	1·92	69	29	52·05	1·60
October	65	27	46·63	1·31	62	27	49·13	3·32
November	58	24	41·93	2·27	57	26	44·64	1·08
December	44	14	30·96	0·51	54	23	39·03	2·70
Year	82	11	46·52	18·67	78	7	46·39	27·01

* Now first published.

	1846.				1847.			
	Max.	Min.	Mean.	Rain.	Max.	Min.	Mean.	Rain.
	°	°	°	in.	°	°	°	in.
January	54	28	41·88	2·08	48	18	34·32	1·45
February.....	61	28	44·23	0·51	54	18	36·09	1·10
March.....	57	21	42·63	0·71	63	17	41·50	1·16
April	63	27	44·82	6·06	61	22	43·67	1·82
May	74	36	53·55	0·90	81	31	53·72	2·93
June	85	40	64·25	2·08	76	41	57·04	1·87
July	89	45	62·18	2·59	80	43	62·97	0·95
August	77	43	62·04	3·95	81	35	58·55	2·57
September	75	40	58·08	0·88	70	28	51·81	0·68
October	63	27	48·27	3·81	63	33	49·24	1·49
November	58	17	43·66	1·55	62	30	45·71	1·40
December	49	10	32·17	0·57	55	27	40·39	3·07
Year	89	10	49·81	25·69	81	17	47·92	20·49

	1848.				1849.			
January	52	12	31·66	1·18	54	13	38·42	1·80
February.....	56	20	40·90	2·44	54	22	41·90	0·61
March.....	61	24	40·24	3·17	58	24	42·24	1·15
April	68	24	43·90	2·18	65	25	43·70	1·76
May	78	31	55·59	1·44	69	29	52·48	1·75
June	77	39	56·30	6·39	76	34	54·68	1·25
July	82	38	58·38	2·10	81	41	57·61	2·44
August	73	35	54·22	3·43	75	40	58·05	1·77
September	73	33	52·58	4·68	75	35	52·35	3·67
October	74	31	47·34	4·13	64	28	45·06	3·48
November	55	24	39·48	0·96	58	20	39·78	1·00
December	56	17	38·56	1·64	54	20	34·72	2·79
Year	82	12	46·60	33·74	81	13	46·75	23·47

	1850.			
January	51	20	30·93	1·81
February.....	54	28	41·57	0·72
March.....	62	13	38·23	0·37
April	61	31	45·66	1·88
May	73	30	48·45	0·97
June	78	38	57·70	2·12
July	78	39	58·58	3·36
August	74	35	56·23	1·32
September	60	34	52·60	1·28
October	61	26	44·09	1·37
November	59	16	42·10	2·00
December	55	21	36·63	0·63
Year	78	13	46·06	17·83

Summary of Results.

	Mean Temp.	Rain.
	°	in.
1842.	48·39	22·83
1843.	47·88	27·20
1844.	46·52	18·67
1845.	46·39	27·01
1846.	49·81	25·69
1847.	47·92	20·49
1848.	46·60	33·74
1849.	46·75	23·47
1850.	46·06	17·83
Average..	47·37	24·103

These Tables present the Maximum, Minimum and Mean of the Temperature for each month, in the years 1842 to 1850 inclusive, as found at Ackworth: also the depth of Rain at the ground. At the foot of each Table are shown the like results for the year.

The Thermometer went up to 89° in July 1846: it sank to 7° in January 1845: the Mean, or avcrage of the whole, is 47·37°; the average of the same period at the Friends' School, by a thermometer exposed more to the sun, is 47·887°. Now the averagc of the nine years 1833–41, which I considered as forming the cold side of a cyclc, was 47·352°, that of the preceding nine years, making the warm side, being 48·952°. We have not therefore, upon either of these two Registers, the evidence of even an approach to the excess of 1·60°, by which the warm was distinguishable from the cold side of that cycle. The probability is, that the period of nine years, commencing with 1851, will not be marked by a very low average, and that we have not now to expect a repetition of the cold exhibited in continuance in the years 1835–41. The amount of Rain does not much differ from past experience: the wettest year, 1848, gave 33·74 in.; thc driest, 1850, 17·83 in.; but the mean yearly result, 24·103 in., shows a greater dryness than I should have expected.—L. H., Aug. 1851.

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§ IV. A DESCRIPTIVE CATALOGUE OF MR. HOWARD'S METEOROLOGICAL AND OTHER SCIENTIFIC WORKS, AND CONTRIBUTIONS TO THE TRANSACTIONS OF SOCIETIES AND PHILOSOPHICAL JOURNALS; COMMENCING WITH AN ACCOUNT OF THE ORIGINAL PUBLICATION OF HIS METEOROLOGICAL REGISTERS.

Earliest series of Observations published.—In the 'Climate of London' (second edition, vol. ii. p. 21–23), after Table IX. for the lunar period July 5 to August 2, 1807, under the head of "*Phænomena observed by the Author, about the same season in two former years*," Mr. Howard has recorded, from his MS. Notes, some observations, made at Plaistow, of an anterior date to any published series. They are noticed here, because they contribute to render thc entire collection more complete, some of the numerical results stated belonging to earlier portions of the year 1806, than those in the earliest regular series, presently to be noticed.

These observations begin with the 15th of July 1805, for which, as well as for the

29th of the same month in the following year, they give, among other results, the temperature of the air at various elevations above the ground, of the surface of the earth, and of water in a pond.

The observations for 1806 commence with the 16th of July, and include the 17th and 29th; together with August 11th, 12th, 14th, and 31st.

Among the sensible phænomena described in these notes are the modifications of Clouds observed, the process of their appearance, their colour, their arrangement in the sky, and in two cases, of *Stratus* and *Cirrostratus* respectively, their temperature. In 1806, a large Meteor is also noticed, and on the 11th of August,—now known to be an annually recurring epoch for shooting stars,—the appearance of above twenty in the space of an hour, from 2^h to 3^h A.M.

The earliest observations of the author published in sequence, simply as series of observations, are those which form part of the "ADDENDA TO THE OBSERVATIONS," concluding the second edition of the 'Climate of London,' in which they were thus first made public. They consist of daily Observations of the maxima and minima of Temperature, as denoted by Six's Self-registering Thermometer, made at the Laboratory, Plaistow, ("previously to the commencement of the regular Tables" of which we shall next relate the publication), from January 28 to November 30, 1806; recording the highest and lowest temperature of the twenty-four hours *ending* at 9 A.M. of each day. They are accompanied by "Notes" on the weather for many individual days of the same period, describing, in brief and general terms, the fall of rain, hail, and snow, the direction of the wind, the occurrence of lightning and thunder, the transit of a meteor and the appearance of halos, &c., together with more particular notices of phænomena attending storms. CLIMATE OF LONDON, Second Edition, vol. iii. p. 380–383.

FIRST PUBLICATION OF THE METEOROLOGICAL REGISTERS IN THE ATHENÆUM MAGAZINE.—The first publication of Mr. Howard's Meteorological Registers took place in "The Athenæum, a Magazine of Literary and Miscellaneous Information (Published Monthly) Conducted by J. Aikin, M.D.;" London, 1807–1809. Octavo. Of this periodical, five volumes appeared, each consisting of the numbers for six months; it commences with the number for January 1807 and terminates with that for June 1809, having thus been continued for two years and a half.

On p. 80 of the first number of the Athenæum, the heading "METEOROLOGICAL REGISTER" denotes that such a register is to be regarded as an integrant part of the

work. This introduces the first paragraph of "*Introductory Remarks on the Register, with an account of the Instruments,*" which is followed, on the next page, by the "METEOROLOGICAL TABLE," beginning with the New Moon, November 10, 1806, and stating, for each day of the lunar month ending December 9, 1807, the direction of the wind, the maxima and minima of Pressure and Temperature, the amount of Evaporation, and the depth of Rain, &c., as observed at Plaistow. The *day* is defined by the statement that each line of the Table comprises the notations of the wind and instruments for a period of 24 hours reckoned *from* 9 A.M. on the day of the date. The Table is followed, on the succeeding page, 82, by "Notes" and "Results," signed "L. HOWARD, Plaistow, XII month 19, 1806."

The "NOTES" or "REMARKS" relate in the same manner as those which accompany the earliest series of published observations as already mentioned, and of which they are in fact the continuation, the particular character of the weather on certain days or terms of days in the lunar months for which the tables are respectively appended to give the instrumental observations, imparting general information not susceptible of being numerically expressed, and rather of an occasional character, not for every day in the month. They include also notices of the conduct of the instrumental observations at particular times, with explanatory and cautionary remarks on the numerical results, adding certain results of an excessive or unusual character to those stated in the Tables.

In this manner are summarily recorded in these Notes,—the phænomena of the Wind, and its direction at particular times; remarkable depressions of the Barometer; the times of maximum Temperature, extraordinary elevations, differences at different heights above the ground; excessive Evaporation; the Vapour-point; the overflow of the river Lea and the consequent flooding of its levels near the place of observation, occasioned by excessive Rains; phænomena of Springs as related to the weather; the structure of Hailstones; remarkable falls of Snow, its evaporation, its amount in the rain-gauge when melted; the occurrence and character of Optical Meteors, including Solar and Lunar Halos and Rainbows, and the circumstances under which they appeared; the *Clouds* observed*, their extent and arrangement in

* The *names* of the Clouds are at first rarely given, but gradually become more frequent, and are most frequent in the observations for the last six months of the series. The reason of this is thus explained by the Author, in the Introduction to the 'Climate of London.' "The Notes appended to my earlier Tables of observations were published in an incomplete state: the confined interest of the subject at that period, and some uncertainty as to the probable reception of the Terms used to designate the clouds, made me sparing of them for two or three years." Vol. i. p. xxvii.

the sky, the investigation of their Electricity by the insulated conductor, their Colour and the Colour of the Sky; the Electricity of the Atmosphere, its nature and intensity as determined by the insulated conductor; the Electricity of Rain; the occurrence of Lightning and Thunder, and their character, the effects of the former in killing animals, and a particular account of certain accidents by lightning at Stockport on the 25th of August 1807 (Athenæum, vol. ii. p. 404); the occurrence, direction, and extent of Storms; an extraordinarily high Tide; the time of appearance and characters of Meteors, their apparent magnitude, and the direction of their motion, nights on which those called shooting-stars were seen; &c. &c.

Among these are given various particulars relating to the animal world, such as the excursions of Bats on certain evenings; the first or early and the last observations of some migratory Birds and the passage of others; the early or late singing of Song-Birds; the times of appearance of certain Insects and their products; but all noticed as a part of the history of the Seasons.

In the Remarks annexed to the Meteorological Table for the month from January 16 to February 13, 1809 (Athenæum, vol. v. p. 251), a particular account is introduced of that very extraordinary period in the weather and in atmospheric phænomena, and of its consequences on the face of nature.

In the "Results" are stated, for each lunar month,—the prevailing direction or the changes of the Wind, its character, its force expressed in general terms, and the accompanying or succeeding weather; the mean height of the Barometer, with remarks on the particular movements and range of the column, and a review of the variations, notices of extraordinary depressions and accompanying phænomena, and suggestions as to their causes; the mean Temperature, not only of the month, but in some cases of particular periods in it also, excluding the effect of extraordinary deviations; the Total amount of Evaporation; and the Total depth of Rain. To these particulars are subjoined the general character or the prominent features of the month, whether in instrumental observation or sensible phænomena, the effects on Vegetation, comparisons of the weather of particular months and seasons, and the character of the latter.

The *Introductory Remarks* explaining the construction of the Register and the method of observation, are continued in the Athenæum for February 1807, and concluded in the number for April*.

The Register is continued in the same form in every number of the Magazine each containing the observations, with the notes and results for a lunar month; the

* On this subject see Introduction.

first, as already stated, being that commencing with November 10, 1806, and the last, inserted in the number for June 1809 (vol. v, p. 537), ending with May 13 of that year, signed "L. H. *Plaistow*, 25th of 5th mo. 1809."

Mr. Howard's Table, Notes and Results, in the greater number of instances are comprised within two pages. In those months in which the Introductory Remarks are added they do not occupy more than three, nor is the same amount of space exceeded except in a single instance, even when the Results of Mr. Hanson's and Mr. Stockton's observations to be mentioned presently, are also inserted. The average amount per month is two pages and one-third. But even this was very reluctantly allotted to Mr. Howard for the purpose by the publishers of the Athenæum, though it had been cordially assented to by the Editor.

Results of Meteorological Observations made by Mr. Thomas Hanson, at Manchester, in 1807, 1808, and 1809, extracted from a monthly register published by him, are in many instances appended, and in a few cases others by Mr. J. S. Stockton, made at Malton, in Yorkshire, in the two latter years, derived from his manuscript registers. These however are entirely unconnected with Mr. Howard's observations, although he was the medium of communicating them to the Editor of the Magazine*.

The Meteorological Tables, together with the Notes and Results, thus first published in the Athenæum, were afterwards reproduced with certain corrections and additions, as explained in another part of this Section, in the 'Climate of London,' first edition, vol. i. Tables I. to XXXI.; second edition, vol. ii. Tables I. to XXXI., p. 2 to p. 75.

* In a letter to Mr. Hanson of the date of October 1808, a copy of which is preserved among Mr. Howard's MSS., he observes, after explaining his grounds for preferring his own form of register, "It is in Temperature that our two Registers disagree most, and indeed so much as almost to defeat the purpose of comparison. By examining a given period of each, the mean Temperature at Manchester will often be found higher than at London, which cannot be the true state of the case. The reason is that the *minimum* which usually occurs towards the end of the night is omitted in thine, while in mine it is preserved. The notation at noon is also too early for the usual maximum."

Mr. Hanson subsequently arranged his observations in a manner similar to that of Mr. Howard, whose form of register was also adopted by Mr. Stockton.

ACCOUNT OF THE ASKESIAN SOCIETY.

Reference being made, in an early part of this Appendix, to a Society at whose Meetings many of the productions of Mr. Howard were first published, it will be proper here to give some account of that body.

The *Askesian Society* was instituted in March 1796, by the association of a number of young men, for their mutual improvement by the discussion of philosophical subjects. The members were such as had recently entered into business, or were engaged in professional occupations: but some of them, since deceased, rose to distinguished positions in life; while others, who still survive, have also attained eminence in their respective pursuits. The Society derived its appellation from ἄσκησις, *exercise*, as indicating the object for which it had been established. The Meetings were held every fortnight during the winter season at the house of the late William Allen, F.R.S., in Plough Court, Lombard Street, and subsequently at the houses of other members, the last being Dr. Babington's in Aldermanbury; and it was the duty of each member, in rotation, to propose for discussion some subject of science or literature within the scope of the Society, and to write a paper upon it, which was read and discussed; a pecuniary fine (for defraying the expenses of the body) being imposed in case of failure. The *founders* of the Society were eight in number, whose names (as yet without titles) follow; Samuel Woods, William Phillips, William Allen, Luke Howard, Joseph Fox, Joseph Ball, W. Hasledine Pepys, Alexander Tilloch. The number of members was at first limited to fifteen, but afterwards extended to twenty.

This scientific association continued in activity for about ten years, and until the changes in life and professional avocations of the members rendered it difficult to conduct its proceedings with regularity. Some of its members belonging also to the British Mineralogical Society, which had been founded a few years later, an endeavour to preserve both societies by uniting them, under the name of the former, was made at the end of the year 1806, but the united society was shortly afterwards virtually superseded by the establishment of the Geological Society of London, of which some of the more active members of the Askesian and British Mineralogical Societies—Mr. Allen, Dr. Babington, Mr. Pepys, Mr. W. Phillips, Mr. R. Phillips, and Mr. Woods—were among the founders or earliest members and office bearers.

Among the members deceased, in addition to Mr. Allen, we have to record the fol-

lowing: Joseph Fox, M.R.C.S., Lecturer on the Structure and Diseases of the Teeth in the Medical School of Guy's Hospital, London; author of two celebrated works on "The Natural History" and "Diseases" respectively, "of the Human Teeth," in which he appears to have enunciated views regarding their nature and vitality more correct than those which had been previously entertained, even by John Hunter himself, and closely approximating to those now established in physiology: William Phillips, F.R.S., to whom mineralogy is indebted, for an extraordinary number of accurate measurements of crystals by the reflective goniometer of Wollaston, which he was almost the first mineralogist to employ; and whose elementary works on that science and on geology, especially on the geology of the British Islands, contributed in a great degree to extend their culture in this country, and to render the latter subject one of general knowledge and interest in society: Dr. Alexander Tilloch, the originator and for many years the Editor and proprietor of the Philosophical Magazine, and who was also the *second* independent inventor of Stereotype Printing. Sir Astley Cooper, and Dr. Babington, to whose professional eminence it will be sufficient thus to allude, and the latter of whom was a most zealous and able friend of science and of those engaged in its cultivation, were also members of this Society. To whom must now be added (1854) Samuel Woods, Esq., F.L.S., President by annual election, and who officiated the whole time as Secretary to the Society. Mr. Woods was afterwards a founder, and the first honorary Secretary of the "London Institution for the advancement of Literature and the diffusion of useful knowledge." Also Richard Phillips, Esq., F.R.S., the Curator and one of the Chemists of the Museum of Practical Geology in London; author likewise of some judicious criticisms on the Pharmacopœia of the London College of Physicians.

Among the members of the Askesian Society now living, beside Mr. Howard himself, are Henry Lawson, Esq., F.R.S., F.R.A.S., well-known as an astronomer, and of late as the munificent donor of a complete collection of astronomical instruments to the newly-founded Observatory at Beeston, near Nottingham. W. H. Pepys, Esq., F.R.S., Vice-President of the London Institution; whose skill and ingenuity in the construction of chemical apparatus have proved such important auxiliaries in the progress of chemical science; and whose researches on respiration, prosecuted in conjunction with Mr. Allen, and published in the Philosophical Transactions, may be said to have established the foundation of our exact knowledge of the chemical changes produced in air by that process; while their preliminary experiments on

carbon and carbonic acid confirmed several points in the chemical history of those bodies, which had remained in doubt or been insufficiently examined; and Joseph Woods, Esq., F.A.S., F.L.S., author of "Letters of an Architect from France, Italy, and Greece," and a well-known Botanist. Mr. Pepys was Treasurer.

The Rules of the Society conferred upon a Committee for Apparatus, consisting of three members, a discretionary power of exhibiting such experiments as they might deem advantageous or interesting to the members; the objects contemplated being the experimental elucidation of facts generally understood, and the examination and repetition of new discoveries. Accordingly, the experiments of Davy on the production and respiration of Nitrous oxide gas, the early experiments in electro-chemistry of Volta and his immediate followers in that science, and in succession those by which Davy had effected the decomposition of the fixed alkalies, were repeated, and exhibited at some of the Meetings. A Course of Lectures on Chemistry was also delivered to its members and visitors by Mr. Allen.

In the Philosophical Magazine for the years from 1800 to 1806, First Series, volumes vii. to xxiv., are contained sixteen papers which had been produced by the members of the Askesian Society and read at its meetings. Of these, three are by Mr. Howard, being that of which the substance is given in the text of this work, with those on Dr. Hutton's Theory of Rain and on the Modifications of Clouds; both of which were republished, in substance, in the "Climate of London." Among the other contributors are Dr. Tilloch, who was the author of five papers; Mr. Woods; Mr. Pepys; Mr. W. Phillips; and Mr. R. Phillips, whose "Analysis of the Hot Springs at Bath" (a consummate example of analytical research at the period of its production) forms one of these papers. Mr. Howard contributed several other papers to the Society, including his essay "On the Proximate Cause of Rain, and on Atmospheric Electricity," subsequently printed in the second edition of the "Climate of London," vol. i. pages 137 to 153; and also noticed in the present volume.

Some of the earliest members of this Society, including Mr. Allen and Mr. Howard, who had themselves been regular attendants at its meetings and effective contributors, as we have seen, to its discussions and inquiries, have recorded their testimony to the accomplishment of the objects for which it had been instituted, in the improved knowledge and habits of cautious and accurate investigation acquired by its members.

The world-wide reputation of William Allen as a *Philanthropist* comes scarcely

within the sphere of this paper; but his Lectures on Chemistry, &c. at Guy's Hospital, and elsewhere, deserve honourable mention; and the following extract from a "Memoir" of his life, by the Rev. Jas. Sherman, exhibits facts of much interest.

"The privations and distress of the poor, from 1799 to 1802, were most deplorable. In addition to the sad consequences of war with France, the summers and autumns of the two last-mentioned years were extremely wet, and deficient harvests caused bread to rise to one shilling and fivepence-halfpenny per quartern loaf, and beef to one shilling per lb. Other provisions were necessarily exorbitantly dear, and many of the poor barely existed. The attention of two Friends, William Allen and William Phillips, was specially directed to the means of affording them relief, and a meeting was called at the house of the latter, to form a society for supplying the poor with soup and meat at one penny per quart. Such a society could now be easily formed, but it was then entirely novel, and created much discussion both as to its propriety and advantages, among otherwise benevolent persons, and it was with some anxiety the founders entered on their operations. However, a subscription was immediately commenced, and in the course of a few days, a committee was formed, sub-committees were appointed, and by a division of labour, the society was quickly organized. Eligible premises were procured in Brick-lane, Spitalfields, and soon adapted to the purpose; and tickets printed and issued to the subscribers. On the first day of delivery the visitors attended under no small anxiety as to the result of their experiment. It succeeded, however, to their utmost wish—the applicants paid the penny per quart with cheerfulness, and carried home a supply of food which they could not have prepared of equal quality, themselves, for four or five times that sum. At first the applicants were served with soup every day; but the distress being very great, the numbers increased so rapidly, that the committee were obliged to adopt the plan of distributing it only every other day to the same person. There were five boilers in the soup-house, capable of making from three thousand to three thousand three hundred quarts, which were daily distributed to above one thousand persons, their money taken and their tickets marked, in less than two hours and a quarter. The effort cost about one hundred and fifty pounds per week; which was provided for by liberal contributions from various classes, including public companies. Into this scheme, William Allen threw all his heart."

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accompany the "Barometrographia."

From the Author – June 1850

PAPERS ON METEOROLOGY,

RELATING ESPECIALLY TO

THE CLIMATE OF BRITAIN,

AND TO THE

VARIATIONS OF THE BAROMETER;

COMMUNICATED TO THE ROYAL SOCIETY AT VARIOUS PERIODS
FROM 1821 TO 1845.

By LUKE HOWARD, Esq., F.R.S.

BEING PART II. OF THE APPENDIX TO BAROMETROGRAPHIA.

LONDON:
RICHARD AND JOHN E. TAYLOR, RED LION COURT, FLEET STREET.
1850.

ADVERTISEMENT.

In the Barometrographia, in the "Notes Historical and Illustrative" for the year 1825, I expressed my intention of consigning to my friend Mr. E. W. Brayley, Jun., F.L., G., and C.S., of the London Institution, (who assisted me in carrying that work through the press,) most of its remaining text, in which he would give an account of my labours, continued through half a century, relative to the periodical variations of the Barometer. It was found impracticable, however, to include that account within the limits of the Barometrographia itself; and therefore, at the conclusion of the work, in the Notes for 1834, I announced my intention of printing and presenting to the Subscribers, as an Appendix, a Memoir on the subject composed by Mr. Brayley, under my inspection, together with some communications to the Royal Society, which had been read but not printed. In the prosecution of this intention, it was deemed expedient to comprehend in one series all my papers communicated to that body, including those already published in the Philosophical Transactions; and the present aspect of Meteorology seeming to invite me to recall the attention of those interested in the science to what I have endeavoured to establish, I have resolved to issue to the Subscribers the present collection of "Papers communicated to the Royal Society," as the *Second* Part of the "Appendix to Barometrographia." Mr. Brayley, by whom it has been edited, is preparing for publication the promised Memoir, which will constitute the First Part, and be presented to the Subscribers when complete.

Copies of the second edition of the "Essay on the Modifications of Clouds," which may assist in elucidating the Notes in the Barometrographia, are now also distributed to the Subscribers.

LUKE HOWARD.

Tottenham, April 1850.

ERRATA.

Page 14[a], note, line 2, *for* p. 36[a] *read* p. 32[a].
line 5, *for* p. 41[a], 42[a] *read* p. 37[a], 38[a].

APPENDIX TO BAROMETROGRAPHIA.

PART II.

PAPERS COMMUNICATED TO THE ROYAL SOCIETY.

CONTENTS.

PAPERS COMMUNICATED TO THE ROYAL SOCIETY.

A METEOROLOGICAL REPORT FOR THE YEAR 1820 IN THE VICINITY OF LONDON*.

THE points most interesting in a practical view of the weather are the depth of *Rain* and the *Mean Temperature*; in other words, the question whether the season will be a *warm* or a *cold*, a *dry* or a *wet* one. Were there no fixed law of variation in these respects, it would answer little purpose to keep meteorological registers; but as the evidence becomes stronger, the more the subject is examined, in favour of the opinion that our seasons do vary in their character, periodically, from year to year, it becomes an object of no small importance to present meteorological results in such a form as shall best exhibit them in connection with the astronomical changes which may be thought most likely to influence the periods of variation. It is for a digest of this kind for the year 1820 that I have to claim the indulgence of the Royal Society.

This paper will embrace the results of two distinct sets of observations on the Barometer, Thermometer and Rain, the most part of which have been made by assistants, in my behalf, at the laboratory, *Stratford*, five miles N.E. from Somerset House; and at my own residence at *Tottenham Green*, about the same distance *north*. It will not be thought a disadvantage, I trust, that the *details* of the former set, of which I here (p. 12[a]) introduce the results alone, are already before the public in a monthly journal†. I find that frequent publication of the observations tends to secure attention and diligence from the observer; and it is manifest that materials thus given cannot be tampered with, when the annual results come to be made up, either to supply defects in observation, or to make the facts bend in any way to theory.

* Read before the Royal Society on the 10th of May 1821, under the title of "Some Remarks on Meteorology," as stated in the usual official letter to the author from Taylor Combe, Esq., at that time one of the Secretaries, dated July 6, 1821; and as recorded also in the Annals of Philosophy, second series, for 1821 (vol. i.), p. 468.

[† In the Annals of Philosophy, from February 1820 to February 1821; first series, vols. xv. and xvi.; second series, vol. i.]

The mean temperature of the year 1820 is by the Stratford register 47·98°; by the Tottenham 48·54°. The latter is the least to be depended on in the present ease; about twenty-four days' observations were neeessarily supplied in it, in different parts, from the other (for vaeaneies *should* be thus filled up, in order to obtain an equilibrium of heat and eold); and I found on examination also, that on different days in the two hot months, the Tottenham thermometer had been pushed up by a clear morning's sun to a degree exeeeding the subsequent maximum of the afternoon, where the sun's rays had been suitably intereepted. These eases were deeided by an appeal to a third thermometer, and with due allowance for them, I think we may take the annual mean this year on the north and east sides of London at 48·16°. Observations of like kind made on the south and west sides might have carried it up, when included in the average, to 48·30°, or even higher. As it is, the heat of the year appears to have been a little below the average of the elimate *out of London*. The thermometer rose this year at Stratford to 91°, and at Tottenham to 92°, on different days, and sunk at both stations to *zero*; the *depression* being at both on the same day. With regard to the distribution of heat in the *four seasons*, if we take the winter *as including the last month of* 1819 and the first two of 1820, and the other seasons at three months eaeh, consecutively, the mean of winter, eompared with the standard of twenty years, was *cold* about 4°; the spring and summer, eaeh cold about half a degree; and the autumn a degree and a half. We had eonsequently the *average heat*, or very nearly, in those seasons when the fruits of the earth required it.

The *Rain* at Tottenham was 24·24 inches, and that at Stratford 23·66 inehes, both reeeived at the surfaee of the earth in gauges of similar eonstruetion. Of the total for the four seasons, limited as above, the winter had less than the standard quantity by 0·42 in., the autumn less by 1·03 in., the spring more by 0·95 in., the summer more by 0·92 in.; but this moderate exeess in the two latter seasons was not, I believe, prejudieial, as there were sixty-three days in the eourse of these in whieh no rain at all appears to have fallen. *The cloudiness* of a very wet season, with the dampness of the air, are prejudieial with us; perhaps in a greater degree than the quantity of water received by the soil.

The *Evaporation* for the year, whieh is 27·24 inehes, appears large, but I do not lay mueh stress on sueh results, obtained in a vessel of only 5 inches diameter.

I have now to speak of the *Barometer* and *Winds*. The mean for the year exhibited in the Table (p. 12ª), 29·95 inehes, was obtained at Stratford by a good barometer of the siphon or wheel eonstruction. I may remark here, that such a barometer is

probably less affected in its results by temperature than an upright one. In the latter, the expansion or contraction of the *whole column* affects the observation; in the former, it is only that in the short leg of the siphon, which, also, it should be noted, affects the observation in a contrary way to that in the upright one. The mean of 1820 is a high one, consistently with the large proportion of *northerly winds*, which will appear on inspecting the columns allotted to the vane; they make, with the east winds, more than half the amount for the year.

Such is the view of the weather of 1820, taken without reference to the periodical variation proper to the year, which is now to be described in the summary way required by the destination of this paper. In doing this, I must necessarily refer to the work I lately published, entitled the "Climate of London." The order of variation of the *annual temperature*, assumed in that work, requires that 1820 should have a temperature near the average of the climate, its position in the series now in progress answering to that of the year 1803 in a former series. That year had a temperature of 0°·17 below the average *in London*, the observations being at Somerset House; the present has a temperature of 0°·34 below the average which, on the best information I could obtain in ten years, I had assigned *to the country*. With respect to *rain*, the year has come equally near to the anticipation thrown out in that work. Its place is the fourth average year after an extreme wet one, answering to the year 1802 in a former series; and we have seen that the product of the gauge at Tottenham was but a fraction of an inch below the average of the climate, which is very nearly 25 inches.

I wish however not to excite much confidence in the series, either of rain or temperature, *as a prospective rule*, until the *principles* on which each of them proceeds shall have been fully ascertained.

The lunar influence is as well marked in 1820 as in either of the two I have before investigated; and this being an average year both in rain and temperature, it differs, as might be expected, in some important particulars, from 1807 and 1816. I shall begin with the effect of this influence on the *winds*; premising that the space now to be examined extends from the 24th of December 1819 to the 12th of the same 1820. It comprehends in 355 days twelve lunar *revolutions*, beginning at the moon's *first quarter*; and thirteen periods of *declination*, reckoned from the day on which the moon crosses the equator going *northward*, to her return to the same position in the same direction.

The days comprehended in each quarter period *of similar lunar declination* (some of them necessarily consisting of six days only) were divided according as they had

the winds northerly or southerly; the east point was given to the northerly and the west to the southerly division; the few variable days being likewise first allotted to one or the other class, on the evidence of another register. The results are as follow:—

	N'ly.	S'ly.
On 87 days, the ☽ north and going north . . .	43	44
91 days, the ☽ north and going south . . .	51	40
91 days, the ☽ south and going south . . .	52	39
86 days, the ☽ south and going north . . .	42	44
Total 355	188	167

The *symmetry* of these results may perhaps surprise others, as it was also unexpected by myself: they stand, however, precisely as they were cast up; not a day in the arrangements or a single observation having been altered in their favour. On the whole, it appears, that while the moon approached us in her course northward, the winds from north and south were so distributed as almost exactly to balance each other in frequency; and that while she receded southward, the northerly preponderated by a fourth part over the southerly winds; and this alike, whether she was north or south of the equator.

On discovering this arrangement, I determined to regard it as the key to the remaining phænomena of the year, and conducting the inquiry accordingly the following were the results:—

Mean height of the barometer for 182 days, with the moon going south	29·880
And for 173 days, moon going north	29·718
Less height of barometer in north course . .	·162 in.
Mean temperature of 182 days, with the moon going south	48·795°
And of 173 days, moon going north	48·347
Lower mean temperature in north course . .	·448°

Consistently with these, the amount of *rain* for the whole time the moon was going north is 14·12 inches, while that for the south course is 9·62—making 4·50 more rain, or nearly in the proportion of 3 to 2 for the north course, in which the barometer and temperature were depressed.

In the dry year of 1807 and the very wet one of 1816, I found these differences

to depend more on the moon's *position* north or south of the equator than on her course in declination; and it seems that an average year differs more in its distribution from a dry or wet one than either of these from the other. The *position* in the present year affects the barometer but little; but it influences the temperature more, as will appear by what follows.

The barometrical mean for the whole of the days in thirteen periods in which the moon was north, is . . . . . 29·7930
and in which the moon was south . . . . . 29·8045

Higher mean for south declination . . . . . ·0115 in.

In 1807 I found this excess ·082; in 1816, ·061. As it becomes less the more accurate the observations, it is *possible* it may turn out at last an apparent and not a real difference; but I think this will scarcely attach to the difference of ·162 inch above stated (p. 4ª), and found in the same observations.

The mean temperature for the north declination is 47·994°, that for south declination 49·148°, excess for south 1·154°; and if we complete the solar year by throwing in fourteen days more of the year 1820, which make another half-period on the north side, the difference will mount up to near 2°; but this is not so fair an average.

The trial of the rain by the same method will introduce us to another and a material part of the subject,—the moon's influence *by her position in her orbit*, which, it appears, must always be considered *along with that of declination*; for in 1807 I found the full-moon weeks almost positively *dry*, with a high barometer, through the solar year. The rain in the periods now before us,

Under south declination amounts to . . . . . 13·49 in.
Under north declination to . . . . . 10·25

More rain under south declination . . . . . 3·24

which is contrary to the indications of a higher barometer and temperature. But on examination of the four summer periods, I find the excess for south declination accounted for in these alone, and that attended with the circumstance of the *full moon* occurring in three of them within the latter week of south declination, and the *new* within the latter week in north. It may be therefore, that in this season, when the effect of *declination* is least sensible, that of the *phase* has operated in its place; and that from this cause the heaviest rains have occurred in the half-periods comprising a full moon.

The criterion for this is, to average the rain for each phasis throughout the thirteen periods, which being done, there appears a total,—

For the weeks following	each First Quarter	8·20 in.
	each Full Moon	5·47
	each Last Quarter	3·63
	each New Moon	5·80

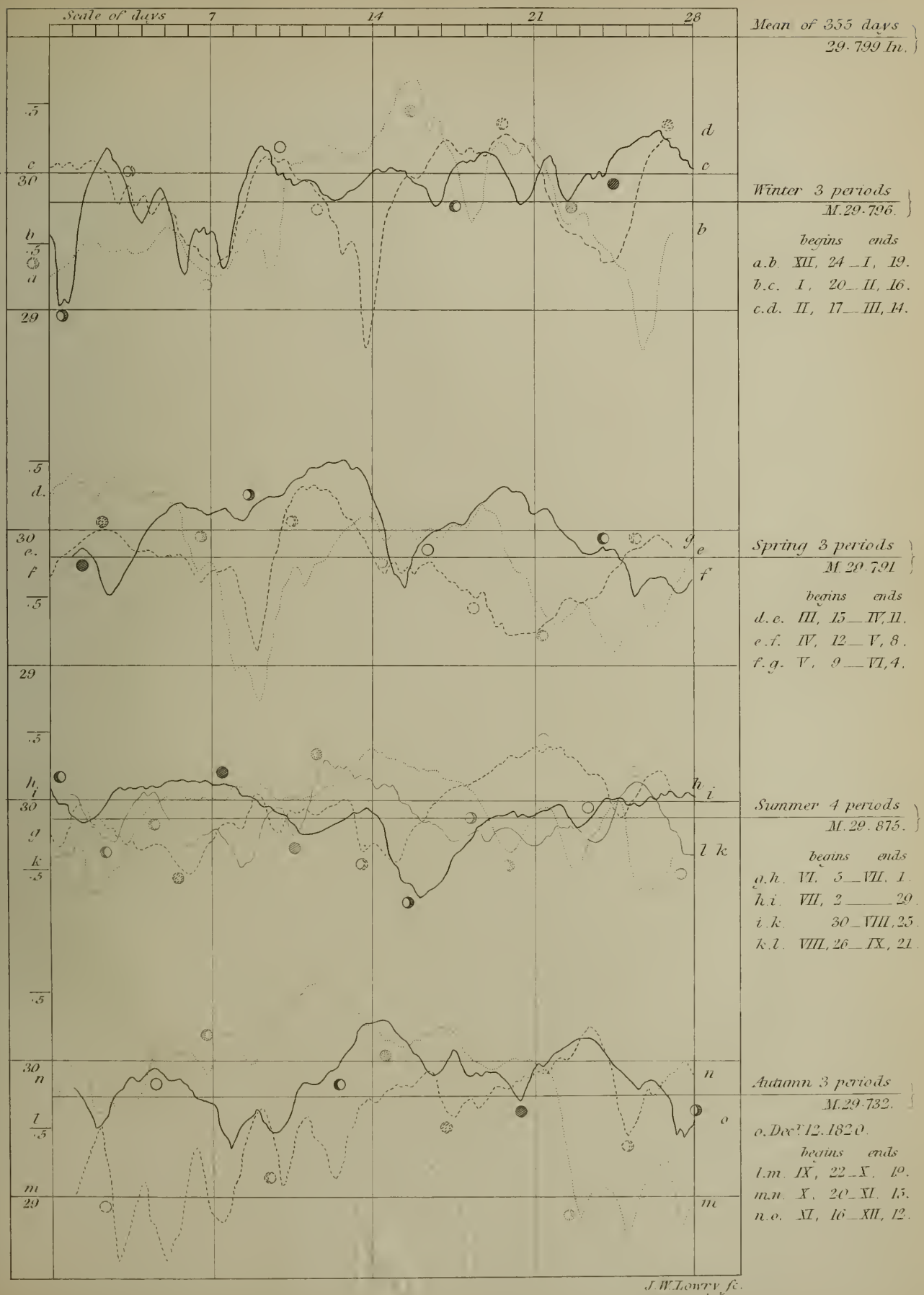
Note.—To obtain these numbers, the rain collected at Tottenham and at Stratford was first summed up separately under each phase: the totals were found so nearly to correspond, that either of the sets would have served equally the purpose of the argument; the average of the two under each phase brought out however the more symmetrical result.

The space in the lunar revolution from the *First Quarter to the Full Moon*, or the approach to the opposition, decided therefore, in this year, the tendency to copious rains; and that between the *Last Quarter and New Moon*, or the approach to the conjunction, brought the dry weather; while the two intervening spaces had each a mean quantity of rain; which may be considered as a proof that the moon in these parts of her orbit had no decided influence on the rain.

It is not to be thought that so manifest a control over the rain should be unaccompanied with some effect on the barometer and thermometer, which I might therefore now proceed to average in connection with the phases; but if the reader has become by this time sufficiently interested in the subject, my purpose will be answered by introducing to him in the annexed diagram and scheme of the whole of the periods, the means of pursuing the examination for himself. I shall therefore conclude this paper with some necessary explanation of these, and a few miscellaneous remarks.

The thirteen curves (Plate Iª.), representing the variation of the barometer for as many periods, were carefully traced from those recorded by the pencil of an attached barometer, on a circular scale, making one revolution in the year, on the face of my clock. They are therefore in some sort an autograph of the variation, and I believe, after every allowance for imperfect straining and the change of form and dimensions in the scale (for the clock shows the variation at three quarters extent only and inverted), they exhibit a register sufficiently full and accurate for the purpose of this inquiry*. I have attached to the curves the sign for each lunar phase in the day on which it occurred: the scale of time, it should be remarked, divides the days at noon. The curves were thrown into groups, nearly commensurate in extent with

[* The method of obtaining these autographic curves of the barometrical variation has been fully described in a former part of this work.]


Moon North
Moon South
Plate 1.a
Scale of days
7
14
21
28
Mean of 355 days
29.799 In.
Bar:
Dec:24
1819.
Winter 3 periods
M.29.796.
begins ends
a.b. XII, 24 _ I, 19.
b.c. I, 20 _ II, 16.
c.d. II, 17 _ III, 14.
Spring 3 periods
M.29.791
begins ends
d.e. III, 15 _ IV, 11.
e.f. IV, 12 _ V, 8.
f.g. V, 9 _ VI, 4.
Summer 4 periods
M.29.875.
begins ends
g.h. VI, 5 _ VII, 1.
h.i. VII, 2 _ 29.
i.k. 30 _ VIII, 25.
k.l. VIII, 26 _ IX, 21.
Autumn 3 periods
M.29.732.
o. Dec.r 12. 1820.
begins ends
l.m. IX, 22 _ X, 19.
m.n. X, 20 _ XI, 15.
n.o. XI, 16 _ XII, 12.
J.W.Lowry fc.

the four seasons, the thirteenth or redundant curve being included in the summer, where on the whole it fell in the most conveniently.

I have annexed to this paper, pages 10ª and 11ª, a scheme which will explain itself on inspection, showing the weekly mean temperature, the mean of the barometer, total of the rain and division of winds for each section of the curves, with a number of incidental remarks bearing on the diagram.

A person who has not before seen anything of the kind may, by contemplating these curves as a whole, and without reference to system, acquire a very competent idea of the character of the barometrical variation in our climate, under different winds and in different seasons. He will soon distinguish the fine upward arches in which it proceeds in fair and warm or frosty weather, from the sharper descending curves which are commonly associated with sudden or more continued gales of wind; and he will probably admire the symmetry of the ascending and descending portions of these curves, which is so far from being improved in this copy that it has rather suffered loss. The return of the atmosphere to its former state of density, after the movement or change which produced elevation or depression, and this through similar gradations, may very well explain these regular proportions. He will probably also not be long in discovering that the range is less, and the upward arches more predominant, in the curves of summer—the last of which in the two weeks in which it enters within the natural limits of the autumnal season and approaches to the equinox, descends by a fine increasing oscillation, and commences that kind of desultory movement in the lower part of the scale, attended with stormy weather, which after a considerable intervening elevation is more fully displayed in the middle of the season.

On looking at the curves again, with reference to the results which have been just laid before him, he will perceive at once, that the more considerable and continued elevations, above the mean line of each group, lie nearly within the limits of the space during which northerly winds are stated to have prevailed, by a fourth part, over the southerly. A number of striking coincidences in the direction of the curves, in the same portion of different periods, will also probably have been noticed. But there is, after all, an important feature in the diagram, which, without a practised eye in such researches, he will have failed to discover; namely, that the whole of it almost is a system of compensations; that the sharp downward curves are, in numerous instances, balanced by an arch placed, with more or less of symmetry, above them; the third curve often taking the intermediate place in the scale.

To give a few examples both of agreement and opposition: the three winter curves,

in their first week, agree, though with very dissimilar modes of approaching it, to turn a point in the scale below 29·50, about the time that the moon is in her highest north declination; these three weeks, it is to be noted, occurring in the same lunar declination, with intervals of twenty or twenty-one days between them, were all *snowy*; and there fell in them the greatest part of the snow of this year. The point I have mentioned being passed, and the moon beginning to go southward, all the three curves take a sudden upward movement (interrupted in one of them and followed in the other by contemporaneous depressions), and thus meet again, in about three days, at 30 in. From hence they diverge into two large compensating movements, with an intermediate undulatory one, converge again, turn a point a little above 30 in. about the twenty-first day of the period, at the moon's extreme south declination; and after falling a few tenths in concert (two of them indeed almost an inch) diverge as before, with an intermediate movement. The particulars of the attendant mean temperature, winds, rains, &c., may be compared with these movements by referring to the scheme. Respecting these, it may suffice to observe here, that on the average of the *compensating* movements, including even the snowy weeks, the winds from northward and southward are *balanced*, the barometer showing a mean height, or about 29·70: but in the three weeks in which the moon was south and going south, and in which, though separated by such long intervals, the barometer still affected a mean of about 30 in., the winds were northerly fourteen days, southerly seven days: facts which place in a very striking light the subordination of the barometer to the winds, and of both to the lunar influence. The two sharpest and most considerable depressions, again, which this season presents, fell respectively close upon the times at which the moon was crossing the equator, going north and south respectively. In both, the barometer appears to have fallen with a south-west and risen with a north-west wind. The storm of the 1st and 2nd of March, which attaches to one of them, was I believe the most severe that has occurred with us for some years.

It appears to be in consequence of these compensating movements, that the heights of the barometer, taken on an average of thirteen periods, nearly coinciding in extent with a solar year, show so nearly alike for the spaces in which the moon is north and south of the equator; while in a succession of particular periods, more especially in winter, the effects of her position, as I have shown in the 'Climate of London,' or of *her course* north and south as here exhibited, are conspicuously opposite. On reflection, since I began the examination of the present results, I am disposed to consider occasional compensations *in every part of the period*, as necessary

to a system of movements caused by lunar influence. If we admit the fact, that the moon's attraction is competent, by causing rarefaction in a certain extent of atmosphere, to give rise to a northerly current in these latitudes, as she moves southward, and to a southerly one as she returns to the north, it will follow, in the nature of things, that this cannot happen at once on every degree of longitude around the circle. When a certain portion of air moves northward, an equal or proportionate volume, according to the density of each, must flow from north to south to replace it. It may do this in a superior or inferior, or (which is more probably the case in the main) in a lateral current, in a region less subject for the time to the direct lunar influence. Let us suppose a set of currents flowing thus in opposite directions on a given degree of latitude around the globe: if we could ascertain the height of the barometer for each degree of *longitude* on this circle, at the same hour, the results might form a curve quite as varied in every season, as those we see represented in this diagram. Let us again suppose the barometer observed from hour to hour at any one station, and the currents shifting their relative positions in such manner as to bring them all successively over the place of observation in the space of seven, fourteen or twenty-eight days, more or less: the results in this case, I apprehend, would present an appearance not very dissimilar to the former. In this way, it is possible, we in this island may be subject, at one time, to the direct current caused by the moon's attraction; which in the past year appears to have been (as to the general movement) from the southward while she came north, and from the northward while she went south: but at another time, we may be immersed in a returning current, the effects of which on the barometer, the temperature and rain must needs be in some considerable degree opposite to those which we should be led to infer from the declination simply considered. The phase again, or the moon's position or course in her orbit, may in some seasons coincide with, and in others counteract the effect of declination, and with the more or less perfect compensation from the north or south (in which the sun's influence on the winds is likewise concerned), we may have great variety in our annual assortment of winds; and with these, of rain, temperature, &c.; but I feel that I am now trespassing on the due limits and object of this paper, which professes to give, not theory or even probable conjecture, but simply a portion of the facts regarding the meteorology of the past year, on which others, more competent than myself, may possibly be induced, by the manifest interest of the subject, to proceed to reason.

☽ North going North.	☽ North going South.	☽ South going South.	☽ South going North.
Mean temp. *a. b.* 7...27·14°	Mean temp. 7...25·07°	Mean temp. 7...24·92°	Mean temp. 6...27·50°
,, ,, *b. c.* 7...34·07	,, ,, 7...41·07	,, ,, 7...40·71	,, ,, 7...37·35
,, ,, *c. d.* 7...34·71	,, ,, 7...35·50	,, ,, 7...32·21	,, ,, 6...41·58
21 days.	21 days.	21 days.	19 days.
Barometer 29·629 *in.*	*Barometer* 29·750 *in.*	*Barometer* 30·069 *in.*	*Barometer* 29·736 *in.*
Rain-gauge 1·04 in.	Rain-gauge 0·88 in.	Rain-gauge 0·14 in.	Rain-gauge 1·07 in.
Winds, N'ly 10, S'ly 11.	Winds, N'ly 11, S'ly 10.	Winds, N'ly 14, S'ly 7.	Winds, N'ly 9, S'ly 10.
Mean temp. *d. e.* 7...43·07°	Mean temp. 7...46·81°	Mean temp. 7...50·07°	Mean temp. 7...47·57°
,, ,, *e. f.* 6...50·09	,, ,, 7...52·85	,, ,, 7...48·42	,, ,, 7...52·57
,, ,, *f. g.* 7...56·57	,, ,, 7...57·21	,, ,, 7...56·28	,, ,, 6...53·17
20 days.	21 days.	21 days.	20 days.
Barometer 29·960 *in.*	*Barometer* 29·863 *in.*	*Barometer* 29·818 *in.*	*Barometer* 29·524 *in.*
Rain-gauge 1·16 in.	Rain-gauge 1·26 in.	Rain-gauge 1·85 in.	Rain-gauge 1·83 in.
Winds, N'ly 10, S'ly 10.	Winds, N'ly 9, S'ly 12.	Winds, N'ly 10, S'ly 11.	Winds, N'ly 7, S'ly 13.
Mean temp. *g. h.* 7...53·21°	Mean temp. 7...54·35°	Mean temp. 7...62·28°	Mean temp. 6...65·17°
,, ,, *h. i.* 7...56·28	,, ,, 7...60·57	,, ,, 7...62·57	,, ,, 7...63·92
,, ,, *i. k.* 6...68·41	,, ,, 7...63·57	,, ,, 7...65·42	,, ,, 7...57·28
,, ,, *k. l.* 7...57·50	,, ,, 7...56·21	,, ,, 7...61·14	,, ,, 6...51·66
27 days.	28 days.	28 days.	26 days.
Barometer 29·837 *in.*	*Barometer* 29·942 *in.*	*Barometer* 29·847 *in.*	*Barometer* 29·875 *in.*
Rain-gauge 1·88 in.	Rain-gauge 1·22 in.	Rain-gauge 3·10 in.	Rain-gauge 3·23 in.
Winds, N'ly 16, S'ly 11.	Winds, N'ly 20, S'ly 8.	Winds, N'ly 15, S'ly 13.	Winds, N'ly 17, S'ly 9.
Mean temp. *l. m.* 7...53·50°	Mean temp. 7...51·14°	Mean temp. 7...48·78°	Mean temp. 7...49·57°
,, ,, *m. n.* 6...45·08	,, ,, 7...43·78	,, ,, 7...43·71	,, ,, 7...41·21
,, ,, *n. o.* 6...39·83	,, ,, 7...41·36	,, ,, 7...42·57	,, ,, 7...49·21
19 days.	21 days.	21 days.	21 days.
Barometer 29·560 *in.*	*Barometer* 29·803 *in.*	*Barometer* 29·948 *in.*	*Barometer* 29·619 *in.*
Rain-gauge 2·00 in.	Rain-gauge 0·81 in.	Rain-gauge 0·36 in.	Rain-gauge 1·91 in.
Winds, N'ly 7, S'ly 12.	Winds, N'ly 11, S'ly 10.	Winds, N'ly 13, S'ly 8.	Winds, N'ly 9, S'ly 12.
Mean temp. of 87 days...47·557°.	Mean temp. of 91 days...48·423°.	Mean temp. of 91 days...49·164°.	Mean temp. of 86 days...49·133°.
Rain 6·08 in.	Rain 4·17 in.	Rain 5·45 in.	Rain 8·04 in.

☽ North going North.	☽ North going South.	☽ South going South.	☽ South going North.
a. b. Frost with much snow.	Frost; a little rain.	Intense cold; snow frequent but scanty till the end.	Temperature at 0°; aurora borealis; thaw at the end, with wind, rain and snow.
b. c. As above	Rain after much wind; floods; fair.	Fine	Fine; a little rain.
c. d. As above	Great storm of wind at the end.	Sequel of the storm; fine; snow.	Fine.
d. e. Fair	Stormy at this depression, with rain and hail.	Fair	Showers; hoar frost at the end; squalls, with thunder clouds.
e. f. Wet at beginning, then fine.	Fine; cirri	Fine; a little rain ..	Fine; a little rain.
f. g. Cloudy; fair ..	Wet and warm; fair at the end.	Rainy; at the close thunder and hail.	Cold showers.
g. h. Cloudy with showers.	Rain; thunder.....	Rain, then fine; temperature at 91°.	Sultry; some rain.
h. i. After a little rain, fine.	Fine	Thunder; considerable rain.	Fine.
i. k. Began with a violent thunder-storm, then fair and showers.	Showers, then fine and warm.	Fine & warm throughout.	A thunder-storm, and then showers.
k. l. Little rain, then fine.	Fine; misty mornings; solar eclipse.	As above	Considerable rain; lunar eclipse.
l. m. Cloudy with rain.	Fine	Fine	Tempestuous about this depression; showers, with hail.
m. n. Stormy; rain, hail and sleet.	Cloudy; rain	Foggy; some rain ..	Fine, then rainy; the first appearance of snow.
n. o. Changeable; foggy; some snow.	Rain, then fine.....	Cloudy, with some wind and rain.	Cloudy; some rain.
Winds. Days.	Winds. Days.	Winds. Days.	Winds. Days.
Northerly 43	Northerly 51	Northerly 52	Northerly 42
Southerly 44	Southerly 40	Southerly 39	Southerly 44

Results of Meteorological Observations made at Stratford, and at Tottenham, near London; for 1820.

1820.	Six's Thermometer. 1. *At Tottenham.* 2. At Stratford.*			Barometer at Stratford.			Evaporation at Stratford.	Rain at Stratford.	Rain at Tottenham.	Winds.								
	Max.	Min.	Mean.	Max.	Min.	Mean.				N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Var. and Calm.
	degr.	degr.	degr.	in.	in.	in.	in.	in.	in.									
1. January	54 52	0 0	30·35 30·50	30·82	29·22	29·99	0·71	1·83	1·54	1	5	3	1	0	11	1	7	2
2. February	53 53	16 15	36·83 36·38	30·42	29·49	30·06	0·90	1·01	1·27	1	9	1	4	1	5	3	3	2
3. March	66 63	20 21	41·42 41·39	30·44	28·91	29·97	2·02	0·37	0·53	4	6	0	3	1	5	2	8	2
4. April	75 72	29 28	49·98 49·38	30·53	29·27	29·98	2·95	1·58	1·88	2	5	2	4	0	7	1	8	1
5. May.....	79 78	27 26	55·53 54·69	30·38	29·21	29·86	3·77	2·85	3·35	0	2	3	2	0	14	6	2	2
6. June.....	92 91	35 34	59·86 57·95	30·41	29·57	30·00	3·44	2·54	2·26	1	2	0	2	0	2	2	20	1
7. July.....	86 86	40 40	62·40 61·13	30·24	29·36	29·97	3·17	3·38	3·64	4	5	1	3	1	3	1	9	4
8. August	83 81	39 38	61·83 61·51	30·30	29·55	29·93	3·62	1·82	1·70	3	5	0	0	0	14	4	5	0
9. September ..	81 82	29 32	55·63 55·37	30·43	29·55	30·07	2·58	2·49	2·76	4	4	1	3	0	5	4	8	1
10. October	64 62	28 25	47·79 47·38	30·60	28·50	29·61	2·12	2·30	1·90	3	5	2	2	3	7	2	7	0
11. November ..	58 57	23 23	41·55 40·80	30·37	29·45	29·97	0·95	1·82	1·75	4	4	5	6	0	4	2	2	3
12. December ..	55 57	22 21	39·37 39·24	30·35	29·47	29·98	1·01	1·67	1·66	1	4	8	2	2	5	5	4	0
On the whole year.	92 91	0 0	48·54 47·98	30·82	28·50	29·95	27·24	23·66	24·24	28	56	26	32	8	82	33	83	18

* [The Tottenham observations of the thermometer, forming the first line of each month, are given in old numerals; those made at Stratford, forming the second line, in modern numerals.]

ON THE LATE EXTRAORDINARY DEPRESSION OF THE BAROMETER *.
[1821.]

The quicksilver having fallen to a lower point in the barometer in the course of last month than any person, probably, remembers to have seen it at, in the neighbourhood of London, a short account of the circumstances may, perhaps, not be unacceptable to the Royal Society.

On the evening of December 24, I found the barometer at 28·20 in., the wind being moderate at S.E., with steady rain, the temp. without, at 8 P.M. 45°. Water boiled freely at 210°. Finding the depression still to continue, I took a portable barometer, on Sir H. Englefield's construction, and having ascertained its height to be, at 11 P.M., 27·96 in., I set it up in my chamber on the first floor. At 5 A.M. the 25th, this instrument gave 27·83 in., and I have reason to think it did not go much lower: the rain had ceased early in the night, and it had become somewhat starlight, with a calm air, and hazy cirrostrati above: soon after five, however, the wind rose again, bringing some rain, apparently from N.W., but there was no tempest that I had opportunity to observe, though it might have blown hard during the few hours I slept. The pencil of my clock barometer travelled precisely to two-tenths below the bottom of the scale, having made a continuous downward sweep of nearly an inch and four-tenths in twenty-four hours: it appears to have turned to rise abruptly, and by 8 A.M. was again on the point of passing 28 inches. In the twenty-four hours *preceding* this time, there had fallen eight-tenths of an inch of rain; in the twenty-four hours *following* it there fell none, nor was the wind, which blew from S.W., at all strong; indeed it was calm all the middle part of the day, with sunshine and cirrus above: evaporation was very perceptible, and the night, up to 10 P.M., starlight. The barometer, at 8 P.M. the 25th, was at 28·40 in. In the early morning of the 27th, not having yet reached 29 in., it turned to fall again, with the wind at S. and S.W., after S.E.: we had again some heavy rain with hail about noon, and by midnight the quicksilver reached 28·07, or ·06 in., where it stood, or rather made minute oscillations, *during the twelve hours following*; a thing I should scarcely have thought possible in our climate.

It was stormy, with much rain, and cloudy during most of this interval; but at noon on the 29th, and from the above-mentioned very low point, the decisive rise

* Reprinted from the Philosophical Transactions for 1822, p. 113; having been read before the Royal Society on the 24th of January in that year.

began; which proceeding in a bold uninterrupted curve into the afternoon of the 31st, the quicksilver once more touched upon 30 inches, with the winds northerly, and moderate; and the year went out with fine weather.

Such were the principal circumstances which met my notice in a depression of the barometer, to which I find no parallel, for London, in the whole Meteorological Annals of the Society. Let us, however, now advert to a case or two which seem to have approached to it. Barker, of Lyndon, gives the following monthly minima, viz. 1782, April, 28·09 in.; 1783, February, 28·08; and March, 27·88 in. (Philosophical Transactions, vol. lxxiii. p. 242, and lxxiv. p. 283). Now, the two latter occurred during the dreadful earthquakes in Calabria, of which we have a record in the Transactions; and I believe the barometer was noted to be extremely low, about that time, in various distant parts of England; but a comparison of the Society's Register is here precluded by a chasm of several years' continuance. I have no doubt, however, from the general appearance of the means in the Lyndon Register, that the barometer there stood commonly some tenths lower than that at Somerset House. With respect to my own, I found yesterday, when the quicksilver was but little above 30 in., that my portable barometer exceeded that at Somerset House, when placed by its side, by 0·05 in., which was likewise, as nearly as I could judge, the difference in excess from my clock barometer. The latter therefore agrees very nearly, in this part of the scale at least, with the barometer registered in the Transactions.

I annex to this paper a diagram, traced from the variation on the face of my clock, for the two latter months of 1821, the scale being three-quarters to an inch, placing at bottom the amount of rain in each successive five days, and the winds, so far as may serve to show their succession*. It will be seen that this great depression was preceded by abrupt changes, fluctuating for thirty days, chiefly between 29·5 and 30 inches, during a continuance of stormy weather; and that the depression itself was fourteen or fifteen days in progress, from the point of 30 inches, to that from which it finally rose in three days.

[* For this diagram the reader is now referred to the plate (II[a]) annexed to the paper on the corresponding Depression of the Barometer in November 1840, in the present collection, p. 36[a]. The dotted line in that plate shows the variation for the two latter months of 1821 above alluded to. The indications of the winds and rain are now omitted in the plate, but will be found stated in a tabular form in the paper itself, pp. 41[a], 42[a]. But as the amounts of rain there stated are for Stratford, those for Tottenham are here subjoined from the original plate as referred to in the text. In the five days to November 5, 0·61 inch; in the ten days to Nov. 15, 1·25 in.; in the five days to Nov. 20, 2·08 in.; to Nov. 25, 0·59 in.; to Nov. 30, 0·62 in.; total for November, 5·15 in. To December 5, 0·81 in.; to Dec. 10, 0·08 in.; to Dec. 15, 0·02 in.; to Dec. 20, 1·20 in.; to Dec. 25, 1·37 in.; to Dec. 30, 1·47 in.; total for December, 4·95 in.]

The rain for these two months is 10·10 inches, a quantity without precedent in the same space of time at London: that is to say, without one on record. Barker gives, however, for "April 1782, 6·125 in.;" and for "May, 5·722 in." at Lyndon; yet the South Lambeth table, given along with his own, exhibits but 6·24 in. for these two months; and states 6·88 in. for the seventh month (July) following, where he has but 2·70 in. I am almost at a loss for an apology to the Society, for having in my last paper anticipated, on the strength of a single analogy, a *dry* year for 1821, the fact being, that there has fallen at Tottenham, in the whole year, no less than 33·84 inches. It seems as if, with all our anxiety to pass the stream of uncertainty in this science, we must give over making the wooden bridges of conjecture, and wait till we can accumulate more solid materials.

Tottenham Green, First Month 10th, 1822.

ON THE WET SUMMER OF 1839*.

The year 1839 having been wet with us in Yorkshire beyond all precedent on record, some notice of the phænomena will perhaps be acceptable to the Royal Society. I shall avoid the minuteness of tabular detail, and make my paper as *readable* as possible; but we must be content to begin in this way, giving the mean temperature and depth of rain for each month, which are as follow:—

				Inches.	
1839.	January.....	Mean temperature	37·04°	Rain 1·13	
	February	„ „	39·64	„ 2·14	
	March	„ „	39·08	„ 3·21	
	April.....	„ „	44·09	„ 0·58	
	May	„ „	49·94	„ 0·38	
	June	„ „	56·35	„ 4·89	
	July	„ „	59·30	„ 5·13	
	August	„ „	58·09	„ 2·94	
	September.....	„ „	54·49	„ 3·43	
	October.....	„ „	48·39	„ 3·40	
	November.....	„ „	43·14	„ 4·54	
	December	„ „	37·29	„ 1·85	
		Mean of the year.....	47·24	33·62	Total for the year.

* Read before the Royal Society on the 20th of February 1840. See Proceedings of the Royal Society, No. 41 (vol. iv.) p. 203.

It will be perceived at once, that the excess of rain lies mainly in the six months from June to November inclusive; six times in the course of this period the *Went*, usually quite an insignificant stream, swelled over its banks, and filled the adjacent meadows—at one time rising to a height at which no one remembered to have seen it.

The monthly results rest on the evidence of two persons registering at nearly a mile from each other; the one my own gardener, the other a young man employed as office-clerk in the Institution belonging to the Friends; both stations are within the limits of the village of Ackworth; the rain-gauges were both of the same construction—that which I have described in the 'Climate of London,' Intr. xvi.; they agreed, upon the amount of the year, within 0·7 in. The thermometers differ: my own is the self-registering one of Six; the other a mercurial one, made to show the extremes of day and night; and from these the daily medium heights were taken to form the monthly mean. The extreme heights differ in the two but little: my own greatest heat is 75°, that of the School 74°; my own greatest cold 18°, that of the School 16°; the mean temperature of the year comes out by the former 47·71°, by the latter 46·76°. I have adopted in these results the medium between the two.

Let us now, bearing in mind that the climatic mean of Ackworth is about 47°, and the mean rain of the year about 26 inches, proceed to notice some of the more remarkable points of this very wet season. The year itself may be said to be marked at its beginning by the prodigious hurricane of the 7th of January, beginning about two in the morning, and blowing for about twelve hours with a force which uprooted many fine trees in our immediate neighbourhood; and snapt off like twigs the strong arms, or twisted off short the spreading heads, of very many of those which in the stem resisted its violence. As has been observed on former occasions, the spray of the sea was borne far inland; indeed there is reason to think that a saline mist passed with the wind, quite across that part of the island, from the Irish Sea to the German Ocean.

There was observed after the storm on the windows of Ackworth School (the solid stone walls of which shook sensibly), as also on our own glass, a white adhering substance, which, being wiped off and dissolved in water and evaporated, showed plainly the crystals of sea-salt. This deposit I also learned was detected in other places far distant from the sea. At *Hull* it was said they lost a whole tide, the Humber being for so long a time reduced, and as it were blown out of its bed. My own evergreens were much disfigured on the windward side, an effect which I observed on returning home in the spring, and ascribed it to the mechanical effects of the storm; but my gardener insists that the saline matter was plentiful on the leaves of

these also. We are distant 2° of longitude from the nearest part of the salt-water to the westward of us.

The next point to be noticed as regards the year is the cold and *wet* March. When this month is in the cold extreme it is commonly dry, as in 1807 and 1808; but we have here an amount of rain of thrice the average for the month, with a temperature about a degree below the mean proper to it. The rains came with a succession of south-east winds of very steady temperature; and in the neighbourhood of London I had opportunity to observe that at the vernal equinox the wind put on a decided southerly type, which lasted a full week; but the precipitation it appears took place to the northward. Here again I would remark, that it has happened at different times to me, in passing to and from the south, to observe the bed of the Trent full with abundant rains, while the Thames was not swelled at all, and *vice versâ*, so that the source of the supply differs in these two; and that wind which brings vapour from the sea up one of the estuaries does not necessarily affect the other. To this wet month succeeded two months of extreme dryness and increasing comparative coldness, not without some more genial intervals: indeed, on the 20th of April, I find noted "a high wind with heavy thunder showers;" and twice in May, in the first and third weeks, "growing weather;" but on the whole it was now "a blighting season, with great want of rain."

The June of this year was, with repeated thunder-storms, the wettest in my remembrance. In 1816, this month had given 4·08 inches to the gauge, with a mean temperature of 59·74°. The Ackworth mean for the present June, (raised 1·65° for the difference of latitude,) makes 58°, or 1·74° colder. July, with a temperature also below the climatic mean, gave about twice the average for the month in rain, which again came in, for the most part, with a south-east wind.

In August the rains were frequent and heavy, though the total exceeds the average only by seven tenths of an inch. The temperature was 3° on the cold side of the mean, and the season was ungenial as regards wall-fruit and some other of our domestic products; but in the fields vegetation was now luxuriant, and it might be said emphatically that "all the trees of the wood rejoiced" in the exuberant supply.

Through September and October the excess of rain continued—always, in the cases where much fell at once, with an easterly wind. The temperature of September was a little cold, that of October in the mean. November was two degrees warm, and the rain exceeded by 50 per cent. the average of even this wettest of all months in the year; such at least it is found by long observation on the east side of the island. The winds from east and south-east continued to be the *importers* of this prodigious supply of vapour; and the north-west usually manifested itself afterwards

as the current which, flowing above, had effected the condensation. See on this subject, Clim. Lond. 2nd Edit. i. 122.

Lastly, December, with a temperature in the mean of the season, fell short of the average by about six tenths of an inch; and thus terminated our long-continued and redundant supply, in this year, of the element without which the sower would cast in his seed, and the planter plant in vain! Let us now recur to some of the effects at large. The winter of 1837–38 had been with us, as in the south, peculiarly destructive to vegetation. Even the hardy oak showed its crippled state in the following season, by weak abortive twigs and bunches of leaves, put forth from the sides of the branches, which are usually clean in thriving timber. These most useful occupants of our hedgerows were also miserably eaten by insects, which left not a leaf where they fed. It was really alarming, even in July, to behold in the woods near us, hundreds of fine trees looking as bare as in mid-winter; the quick-thorns in our hedges have suffered also much in this way, and the mischief not confined to one season, but extending through several, as in the case of the oaks. The apple-trees were severely pinched, and but little bearing wood was formed upon them: the winter of 1838–39 and a blighting spring had nigh completed their destruction; so that rain, and that in great and continued abundance, could not have come more in season than it did the last summer. We shall see shortly whether the insect enemy of our woods and hedges has been brought under by a season so opposite to that which favours its multiplication*.

On the favourable side of the question we may now revert to productions of the field and garden, not requiring so much of the sun's power; which throve for the most part to admiration. I think I never saw the gooseberries and currants finer in leaf and berry: the crops from them, as also from the raspberry and Morella cherry, were abundant; the celery was never so fine with us. The potatoes, as might be expected, did well: and their congeners the dahlias, which had looked but shabby in the spring, and in the south had been mostly cut off, resumed their growth and attained in the more sheltered beds above six feet of height, with an exuberant show of fine flowers, lasting into December.

As to field crops, the wheat in July, after flowering, stood up well and looked magnificent, but the heavy storms had brought most of it down before it began to ripen; and the straw and ears at harvest appeared as weather-beaten as if they had been all winter in the thatch of a rick. The beans were coming into bloom quite short and meagre, but the rain at once "made their fortunes;" and we had even, as

* *Note*, 1849.—This very wet season did effectually restore our timber to a healthy vegetation, the insect enemy being dislodged from its quarters.

now and then happens, a second flowering and a second crop, on the aftershoots at the top of the stem: not an aphis was anywhere to be seen upon the plants. Turnips, it was observed, though a good crop, would have been larger with more of warmth. Of grass and clover, I need not say we had plenty, and that up to quite a late period; and those who carefully watched for the dry intervals, and diligently used them, got their crops pretty well; but some portion was inevitably damaged or lost. It is plain, that, with some minor inconveniences and losses attending it, this very wet summer, coming as it did, has been productive of a great and general good.

Tottenham, 23rd January, 1840.

ON CERTAIN VARIATIONS OF THE MEAN HEIGHT OF THE BAROMETER, MEAN TEMPERATURE AND FALL OF RAIN, CONNECTED WITH THE MOON'S PHASES, IN THE CYCLE OF YEARS FROM 1815 TO 1823*.

Some observations made as far back as the year 1798, on the subject of this paper, will be found treated in the 'Climate of London†,' vol i., under the head of "Periodical variations." In the same division of the work, I have submitted the very dry year 1807 and the very wet year 1816 to an examination in respect of the natural periods and efficient causes of these variations in the atmosphere of our own climate. The results, as far as they went, were satisfactory, and tended to encourage further search, the materials for which were presented in the work itself; but I do not find that anything has yet been done with them by others. In the mean time, the curiosity of the public on these subjects increases; and too many seem prepared to feed it with anything but real knowledge—the result of actual observation and fair inferences. I shall not here revert to what I have before published: my purpose in this paper is to show what may be done by such an inquiry extended through a period of nine years: and I have selected, as the most perfect in detail and most suitable to my present aim, the nine years from 1815 to 1823 inclusive; the observations being all in the neighbourhood of London. I shall not be able to complete

* Read before the Royal Society on the 12th of March, 1840. See Proceedings, No. 42 (vol. iv. p. 211).

[† The present and all future references to the 'Climate of London,' contained in this collection of Papers communicated to the Royal Society, unless otherwise stated, are to the second edition of that work, published in 1833.]

the subject in one communication; that which is now presented will, however, make of itself a whole.

The annexed Table contains calculations made on the daily mean height of the barometer, the daily mean temperature, and the daily product of the rain-gauge at the level of the ground, cast into periods of six, seven or eight days, in such manner as to bring *the day of the lunar phase* belonging to it *into the midst of the time.* This appeared to be the best mode of ascertaining effects which plainly come on and go off by degrees, and are measurable by such determinate periods, provided they be closely connected in time with the apprehended cause; and we have nothing to lead us to infer the contrary at present.

The mean height of the barometer for the whole of the period of nine years here examined is 29·8118 inches. The mean temperature for the same 49·235°.

The total of rain fallen 232·51 inches.

I shall now proceed to exhibit the results, as manifested under the several lunar phases occurring in the period.

Full moon.	Last quarter.	New moon.	First quarter.
1815. Beginning 23rd Dec. 1814; comprehending 363 days.			
29·6789 in.	29·9209 in.	29·8475 in.	29·9159 in.
48·497°	49·897°	50·415°	50·053°
*a*9·31 in.	3·25 in.	4·84 in.	4·51 in.
1816. Beginning 20th Dec. 1815; comprehending 369 days.			
29·7051 in.	29·7245 in.	29·8730 in.	29·6716 in.
46·711°	47·237°	45·734°	48·074°
9·61 in.	*b*5·69 in.	*c*6·42 in.	9·89 in.
1817. Beginning 23rd Dec. 1816; comprehending 363 days.			
29·7597 in.	29·8963 in.	29·7356 in.	29·8037 in.
49·076°	48·794°	48·011°	48·177°
8·25 in.	4·12 in.	6·06 in.	*d*8·25 in.
1818. Beginning 20th Dec. 1817; comprehending 369 days.			
29·8577 in.	29·8342 in.	29·8091 in.	29·7557 in.
48·660°	47·750°	51·790°	51·346°
*e*7·91 in.	*f*6·55 in.	7·14 in.	4·33 in.
1819. Beginning 24th Dec. 1818; comprehending 361 days.			
29·8807 in.	29·8795 in.	29·8315 in.	29·8196 in.
52·914°	50·545°	48·055°	49·497°
5·91 in.	3·93 in.	*g*7·24 in.	5·74 in.
1820. Beginning 20th Dec. 1819; comprehending 370 days.			
29·7545 in.	29·8887 in.	29·9314 in.	29·7575 in.
49·212°	47·601°	48·133°	48·724°
*h*7·77 in.	3·64 in.	4·60 in.	*i*9·63 in.

Full moon.	Last quarter.	New moon.	First quarter.
1821. Beginning 24th Dec. 1820; comprehending 361 days.			
29·9199 in.	29·7845 in.	29·7807 in.	29·8383 in.
47·930°	48·930°	50·214°	52·402°
5·90 in.	*k* 6·96 in.	6·38 in.	9·15 in.
1822. Beginning 21st Dec. 1821; comprehending 369 days.			
29·8110 in.	29·9142 in.	29·8216 in.	29·8505 in.
51·587°	51·479°	50·695°	51·347°
5·37 in.	5·90 in.	*l* 7·63 in.	*m* 7·62 in.
1823. Beginning 25th Dec. 1822; comprehending 361 days.			
29·7708 in.	29·7677 in.	29·7410 in.	29·8030 in.
46·982°	51·765°	47·346°	46·886°
n 5·99 in.	6·86 in.	7·18 in.	2·98 in.

Note.—In the instances in which the rain of *thirteen* lunar weeks (instead of twelve as usual) enters into one of the sums, that result is marked by a letter, and the quantities by which they thus exceed are as follows:—In (*a*) 0·81 in., (*b*) 1·22 in., (*c*) 0·20 in., (*d*) 2·52 in., (*e*) 0·52 in., (*f*) 0·14 in., (*g*) 1·00 in., (*h*) 0·51 in., (*i*) 1·03 in., (*k*) 0·99 in., (*l*, *m*) none, (*n*) 0·48. So much to assist the comparison in detail. The differences do not affect the general results, but there will be found in this table some agreements and gradations in the particular results of each class, which are worth studying, though not made use of in this paper.

The sum total of the barometrical heights here brought together under the phase

of full moon, is . . . . . 268·1383,
which divided by 9 gives . . . 29·793144 in.
Of last quarter . . 268·6105,
which divided by 9 gives . . . 29·845611 in.
Of new moon . . 268·3714,
which divided by 9 gives . . . 29·819044 in.
Of first quarter . . 268·2158,
which divided by 9 gives . . . 29·801755 in.

Then, if we begin with the last quarter, we have here a pretty regular *gradation in descent* of the barometrical column (the quantities lessening in geometrical proportion) through three parts of the lunar orbit; thus, L.Q. to N.M. −·026567 in.; N.M. to F.Q. −·017289 in.; F.Q. to F.M. −·008611 in.; after which F.M. to L.Q. +·052467 in.; the atmosphere under this phase recovering the whole weight it had lost in the preceding three.

This is an effect which no one who has at all studied the subject would be dis-

posed to attribute to accidental causes. It is clearly due primarily to the modified attraction of our attendant planet: how exercised, to bring on these changes, we have to inquire in another part of these papers.

Next as to the mean temperatures, their sum total under the

Full moon is . . 441°·569÷9=49°·06322
Last quarter . . 443°·998÷9=49°·33311
New moon . . 440°·393÷9=48°·93255
First quarter . . 446°·506÷9=49°·61177

Here we find, in place of the former gradations, a rising and falling alternately. The temperature under the last quarter having approached near to the general mean (or 49·235°) in descent, the new-moon temperature sinks considerably below it; the first quarter brings up the temperature to its maximum for the lunar revolution, and the full moon carries it down again by a movement much the largest of the four, the difference exceeding half a degree of Fahrenheit, in such calculation a very sensible quantity. I shall return to this comparison when we have done with the next head—the rain.

In estimating the temperatures under the several phases, it was needful to make the observations taken extend as nearly as possible through a solar year. And it was convenient to do this also with the barometer, the mean height of which is sensibly affected by the season, as determined by the sun's declination (see Clim. Lond. i. 205–212). But in the case of the rain, where we have to do, not with mean results, but with detached periods and quantities, we are at liberty to confine our attention to the phase strictly, and to a lunar cycle comprehending a certain number of each phase. I have accordingly thrown off the quantity (which is about three inches) found between the end of October 1823 and the conclusion of my ninth solar year in December 20th of that year: the proportions under each phase are then as follows:—

Rain in a lunar cycle of 8 years 312 days, 229·48 in. (being about $25\frac{1}{2}$ in. in each year), of which, under the Full moon . . 65·54 in.
Last quarter . . 46·55 in.
New moon . . 55·56 in.
First quarter . 61·83 in.

These quantities are not affected by the differing length of the periods, (as completed in twelve or thirteen weeks,) belonging to the years separately. I have noticed these anomalies under the Table already; but we have here as clear, though not so regular a gradation in the amount of rain under each phase, as before in the height

of the barometrical mean. The last quarter, which had the highest barometer with a temperature a little above the mean, shows the least depth of rain. The new moon, with a considerably depressed temperature and lower barometer, brings an increase of rain. The effect of the first quarter is still to lower the barometer, but to raise the temperature almost to the point it had fallen from, the rain increasing still, but not in an equal ratio. Lastly, the full moon brings down the temperature again, and, with the barometrical average at its minimum, we have now the maximum of rain. And it appears that, during this lunar cycle, the approach of the last quarter was the signal for the clearing up of the air and the return of sunshine.

TABLES OF THE VARIATION, THROUGH A CYCLE OF NINE YEARS, OF THE MEAN HEIGHT OF THE BAROMETER, MEAN TEMPERATURE AND DEPTH OF RAIN, AS CONNECTED WITH THE PREVAILING WINDS, INFLUENCED IN THEIR DIRECTION BY THE OCCURRENCE OF THE LUNAR APSIDES; WITH SOME CONCLUDING OBSERVATIONS ON THE RESULT*.

Table I.—1815.

Under Apogee.					Under Perigee.				
	Wind.	Mean barometer.	Mean temp.	Rain.		Wind.	Mean barometer.	Mean temp.	Rain.
		inches.	degr.	in.			inches.	degr.	in.
					Dec. 27 [14].	S.E.	29·195	38·0	1·25
January 11 ..	N.W.	29·700	36·0	0·28	January 24 ..	Var.	29·575	24·5	0·57
February 7..	Var.	29·625	44·0	0·55	February 22 .	N.W.	30·175	48·0	0·05
March 6	W.	30·035	47·5	1·05	March 22 ...	S.W.	29·425	53·0	0·67
April 3	Var.	29·860	47·5	0·53	April 19	Var.	30·015	48·5	1·18
May 1.....	E.	29·660	58·5	0·27	May 13	S.W.	29·600	55·0	0·38
May 29	Var.	29·825	59·5	0·61	June 10	N.W.	29·760	58·5	1·21
June 25	N.E.	29·935	53·5	Fair.	July 8.....	N.W.	29·980	56·5	0·02
July 23	N.W.	30·010	60·5	0·27	August 5....	W.	29·755	60·0	0·25
August 19 ..	W.	29·675	56·0	1·02	September 2 .	S.W.	29·910	65·0	0·06
September 15	S.E.	29·710	65·5	0·20	October 1 ..	S.W.	29·605	50·5	0·63
October 13 ..	Var.	29·690	56·5	0·39	October 29 ..	N.E.	29·920	51·5	Fair
November 9 .	S.W.	29·920	49·0	1·13	November 24	N.W.	29·370	34·5	0·18
December 7 .	N.E.	29·865	30·0	Fair	December 20	S.W.	29·135	41·0	0·31
Mean	....	29·8085	51·077	6·30	Mean	....	29·7443	48·893	6·76

* Read before the Royal Society on the 14th of May, 1840. See Proceedings, No. 43 (vol. iv. p. 226).

TABLE II.—1816.

Under Apogee.					Under Perigee.				
	Wind.	Mean barometer.	Mean temp.	Rain.		Wind.	Mean barometer.	Mean temp.	Rain.
		inches.	degr.	in.			inches.	degr.	in.
January 4 ..	S.W.	30·255	31·5	0·69	January 16..	S.W.	29·460	40·5	0·75
February 1 ..	S.E.	29·800	27·0	1·78	February 14 .	W.	30·350	32·0	0·07
February 28 .	N.W.	29·820	31·0	0·90	March 13 ..	W.	29·835	39·5	0·43
March 26 ..	N.E.	30·150	38·5	Fair	April 11	N.E.	29·555	44·0	0·88
April 23	E.	29·750	56·5	0·05	May 9.....	S.W.	29·500	47·5	0·63
May 20	E.	29·910	50·5	0·48	June 5	N.W.	29·750	54·0	0·70
June 17	S.W.	29·940	56·5	1·06	June 30	Var.	29·675	64·5	0·50
July 15	S.W.	29·710	61·5	1·21	July 27	N.W.	29·825	58·5	0·30
August 12 ..	N.W.	30·010	61·5	0·64	August 24 ..	N.E.	30·160	57·5	0·23
September 8 .	S.W.	29·765	56·0	0·73	September 21	S.E.	29·685	55·0	0·15
October 5 ..	W.	29·855	59·0	0·81	October 20 ..	W.	29·580	44·5	0·59
November 1 .	Var.	29·315	42·5	1·22	November 17	S.W.	29·900	35·5	0·07
November 29	N.	30·345	37·0	0·11	December 15	W.	29·105	35·0	0·20
Mean	....	29·9096	46·846	9·68	Mean	....	29·7215	46·770	5·50

Note.—The *rain* is the quantity fallen in a week *following* the apsis; the mean heights of the barometer and thermometer apply to the day of the date.

TABLE III.—1817.

Dec. 27 [16].	N.W.	29·575	35·0	2·42	January 9 ..	E.	30·559	25·5	1·03
January 24 ..	S.W.	30·200	47·5	0·06	February 4 ..	S.W.	29·760	39·0	0·41
February 20 .	S.W.	29·565	40·5	0·31	March 5	W.	29·100	40·5	0·81
March 20 ..	N.	29·775	29·0	0·20	April 2	S.E.	30·360	45·5	0·01
April 16	N.	29·925	40·0	0·02	April 30	N.E.	29·760	44·5	0·10
May 14	W.	29·670	50·0	1·00	May 29	N.E.	29·690	49·5	0·34
June 10	N.W.	29·865	53·5	0·46	June 26	W.	29·675	67·0	1·07
July 8.....	S.W.	29·805	58·5	0·85	July 23	S.W.	29·935	60·0	0·67
August 5....	N.E.	30·035	59·0	0·55	August 17 ..	W.	29·810	55·5	0·52
September 1 .	N.E.	30·050	53·0	Fair	September 13	S.E.	29·945	59·5	0·21
September 29	N.W.	29·955	50·5	Fair	October 11 ..	N.E.	29·970	43·0	0·63
October 27 ..	S.W.	29·475	40·5	0·64	November 9 .	W.	29·785	45·5	1·12
November 23	W.	29·975	43·5	0·23	December 7 .	S.W.	28·970	37·0	1·01
December 20	....	....	....	0·15					
Mean	....	29·8361	46·200	6·89	Mean	....	29·7930	47·077	7·93

Table IV.—1818.

Under Apogee.					Under Perigee.				
	Wind.	Mean barometer.	Mean temp.	Rain.		Wind.	Mean barometer.	Mean temp.	Rain.
		inches.	degr.	in.			inches.	degr.	in.
Dec. 20 [17].	N.E.	29·455	33·5		January 5 ..	Var.	29·610	35·0	0·91
January 17 ..	W.	29·885	36·0	0·30	February 1 ..	Var.	28·940	32·5	Fair
February 13 .	N.E.	29·915	30·5	0·42	February 27 .	..	29·400	38·0	1·31
March 13 ..	N.	29·550	35·5	0·12	March 25 ..	N.W.	29·585	37·5	0·56
April 10	S.	29·310	48·5	0·57	April 22	S.E.	29·530	55·5	1·52
May 7.....	S.W.	29·375	52·5	1·65	May 20	E.	30·125	50·0	Fair
June 4.....	S.E.	30·220	58·5	Fair	June 18	N.W.	29·735	62·0	0·54
July 1	N.E.	30·075	56·5	Fair	July 16	N.E.	30·215	75·0	Fair
July 29 ...	S.W.	30·205	68·5	0·12	August 13 ..	N.E.	30·120	60·5	Fair
August 25 ..	N.W.	29·980	61·0	0·10	September 9 .	N.W.	29·675	53·0	0·25
September 22	S.E.	29·670	58·5	1·62	October 4 ..	S.W.	29·430	56·5	0·22
October 20 ..	S.E.	30·125	46·0	0·13	October 31 ..	S.W.	29·970	51·5	0·31
November 16	S.W.	29·570	46·5	0·43	November 29		30·250	52·0	0·20
December 14.	N.E.	30·175	38·0	0·14					
Mean	....	29·8221	47·857	5·60	Mean	....	29·7373	50·692	5·82

Table V.—1819.

					Dec. 27 [18].	S.E.	30·260	35·5	Fair
January 10 ..	S.W.	29·640	44·5	0·61	January 25 ..	S.E.	29·350	43·0	0·69
February 6 ..	W.	29·460	43·0	0·68	February 22 .	Var.	29·600	39·5	0·90
March 6	N.E.	29·935	43·0	Fair	March 21 ..	N.W.	29·710	40·0	0·59
April 3	N.	30·065	55·5	0·43	April 16	S.	29·170	51·0	1·08
April 30	S.E.	29·775	44·0	0·68	May 12	N.W.	30·070	60·0	0·48
May 28	N.E.	29·910	46·5	0·14	June 9.....	S.	29·695	63·0	0·63
June 25	S.W.	29·650	60·5	0·43	July 8	N.W.	30·075	61·0	0·03
July 22	N.W.	30·100	56·0	Fair	August 5....	N.W.	29·995	61·0	Fair
August 18 ..	N.	30·295	68·0	Fair	September 2 .	N.W.	29·660	64·0	0·37
September 14	S.E.	30·025	61·0	0·45	September 30	S.W.	29·795	64·5	0·10
October 12 ..	S.W.	30·030	67·0	Fair	October 27 ..	N.W.	29·855	35·5	0·94
November 9 .	N.W.	29·650	38·0	0·80	November 21	N.W.	29·360	35·5	Fair
December 7 .	N.E.	30·035	36·5	0·10	December 29	S.W.	29·700	53·0	0·95
Mean	....	29·8900	50·040	4·32	Mean	....	29·7353	50·464	6·76

Table VI.—1820.

Under Apogee.					Under Perigee.				
	Wind.	Mean barometer.	Mean temp.	Rain.		Wind.	Mean barometer.	Mean temp.	Rain.
		inches.	degr.	in.			inches.	degr.	in.
January 3 ..	N.W.	29·910	25·5	0·10	January 16 ..	N.W.	29·615	25·0	1·05
January 31 ..	S.W.	29·955	39·0	0·10	February 13 .	S.E.	30·085	36·5	0·60
February 27 .	N.E.	30·030	32·0	0·18	March 13 ..	N.W.	29·825	42·5	Fair
March 25 ..	N.	29·465	37·5	0·08	April 10	S.E.	29·375	40·0	0·88
April 22	E.	30·425	49·5	0·28	May 8.....	S.E.	29·595	57·5	0·14
May 20	S.W.	30·290	56·0	1·02	June 2.....	W.	29·665	53·5	0·81
June 17	N.W.	29·970	57·5	0·76	June 29	S.E.	30·020	63·5	0·53
July 14	N.E.	29·850	65·0	2·31	July 27	N.W.	29·985	66·0	0·76
August 11 ..	N.W.	30·210	63·0	Fair	August 24 ..	S.W.	29·955	59·0	0·41
September 7 .	S.E.	30·150	60·0	Fair	September 21	W.	29·475	48·5	0·23
October 4 ..	N.E.	30·450	51·0	0·09	October 20 ..	W.	29·045	44·5	1·29
November 1 .	N.W.	29·605	45·0	0·26	November 17	S.E.	29·670	36·0	0·97
November 29	N.E.	30·250	37·0	0·11	December 14	N.E.	29·915	34·5	0·47
Mean	....	30·0430	47·540	5·29	Mean	....	29·7095	46·692	8·14

Table VII.—1821.

Dec. 26 [20] .	E.	29·765	30·5	Fair.	January 7 ..	N.	29·080	36·5	2·40
January 23 ..	N.E.	30·720	33·5	Fair	February 4 ..	W.	30·265	34·5	Fair
Feb. 20	N.W.	30·100	35·0	0·08	March 4	S.W.	29·825	43·5	1·12
March 19 ..	N.W.	29·150	39·5	0·36	April 2	W.	29·165	48·0	0·36
April 15	S.W.	29·415	42·0	0·57	April 30	N.E.	29·985	48·0	0·07
May 13	N.W.	29·250	47·0	1·37	May 28	N.W.	30·020	48·0	0·11
June 9.....	N.W.	29·705	54·0	0·30	June 25	N.E.	30·085	60·0	1·41
July 7.....	N.	30·075	51·5	0·07	July 20	W.	29·750	65·5	0·76
August 4....	S.	29·920	64·0	0·41	August 16 ..	W.	30·060	68·5	Fair
September 1 .	N.W.	29·940	63·0	0·26	September 13	N.W.	29·935	58·0	0·19
September 28	S.W.	29·625	58·5	0·58	October 11 ..	S.E.	29·690	52·0	0·21
October 25 ..	S.W.	29·990	47·5	0·23	November 9 .	E.	30·085	42·0	0·90
November 22	S.W.	29·525	50·0	0·75	December 7..	S.E.	29·850	44·5	0·05
December 19 .	S.W.	29·125	42·0	1·52					
Mean	....	29·7360	47·000	6·50	Mean	....	29·8304	49·923	7·58

Table VIII.—1822.

Under Apogee.					Under Perigee.				
	Wind.	Mean barometer.	Mean temp.	Rain.		Wind.	Mean barometer.	Mean temp.	Rain.
		inches.	degr.	in.			inches.	degr.	in.
					January 4 ..	N.E.	29·475	36·0	0·02
January 16 ..	N.W.	30·085	30·5	Fair	January 31 ..	S.W.	30·190	45·0	0·60
February 13 .	S.E.	30·030	43·0	0·20	February 25 .	N.W.	30·100	49·5	0·02
March 12 ..	S.W.	30·170	40·5	0·12	March 24 ..	W.	29·605	44·5	0·41
April 9	N.E.	30·015	39·5	1·46	April 22	S.	29·240	49·5	0·34
May 6.....	N.W.	29·685	63·0	0·51	May 20	S.E.	30·160	70·0	0·44
June 3.....	E.	30·180	63·0	Fair	June 18	S.	30·050	63·5	0·05
June 30	S.W.	29·980	61·5	0·86	July 16	N.	29·650	66·0	0·83
July 28	S.W.	29·425	64·0	0·53	August 12 ..	S.W.	29·750	67·0	0·11
August 24 ..	S.W.	29·675	60·0	1·18	September 6 .	S.W.	29·930	59·5	Fair
September 21	N.E.	29·835	57·0	1·41	October 3 ..	S.E.	29·695	57·5	0·83
October 19 ..	S.W.	29·405	53·5	0·74	October 31 ..	S.E.	29·750	52·5	0·10
November 16	N.E.	29·325	38·0	1·46	November 29	S.W.	29·200	38·5	1·49
December 13	E.	30·230	34·5	Fair					
Mean	....	29·8492	49·846	8·47	Mean	....	29·7532	53·769	5·24

Table IX.—1823.

					Dec. 27 (22).	E.	30·270	24·0	0·25
January 9 ..	N.E.	29·860	26·5	0·50	January 24 ..	N.E.	29·775	25·0	0·79
February 5 ..	E.	29·625	30·5	1·09	February 21 .	N.W.	29·360	44·0	0·93
March 5	N.W.	29·565	39·0	0·26	March 20 ..	S.W.	29·375	43·0	0·48
April 2	S.W.	29·635	47·5	0·99	April 14	E.	30·200	45·5	0·07
April 30	S.E.	30·385	47·5	Fair	May 12	S.W.	29·525	55·5	0·16
May 27	N.E.	29·935	57·5	0·35	June 9.....	N.W.	29·880	54·5	Fair
June 24	N.W.	29·710	56·5	1·23	July 7.....	W.	29·605	58·5	0·40
July 21	S.W.	29·635	60·0	0·90	August 5 ..	N.W.	29·720	60·0	0·24
August 17 ..	W.	29·845	57·0	0·36	September 2 .	S.W.	29·985	60·5	Fair
September 14	S.W.	29·350	69·5	0·28	September 29	N.	29·500	47·5	1·38
October 12 ..	S.W.	29·150	48·5	0·12	October 24 ..	E.	30·140	46·5	1·93
November 9..	N.E.	30·450	39·0	*Fair*	*November* 20.	S.W.	30·050	45·5	*Fair*
December 6..	N.E.	30·150	35·0	0·04	*December* 18.	W.	29·600	35·0	0·56
Mean	....	29·7920	47·230	6·12	Mean	....	29·7846	46·071	7·19

Summary of Results.

Under Apogee.				Under Perigee.			
	Mean barometer.	Mean temp.	Rain.		Mean barometer.	Mean temp.	Rain.
	inches.	degr.	in.		inches.	degr.	in.
1815	29·8085	51·077	6·30	1815	29·7443	48·893	6·76
1816	29·9096	46·846	9·68	1816	29·7215	46·770	5·50
1817	29·8361	46·200	6·89	1817	29·7930	47·077	7·93
1818	29·8221	47·857	5·60	1818	29·7373	50·692	5·82
1819	29·8900	50·040	4·32	1819	29·7353	50·464	6·76
1820	30·0430	47·540	5·29	1820	29·7095	46·692	8·14
1821	29·7360	47·000	6·50	1821	29·8304	49·923	7·58
1822	29·8492	49·846	8·47	1822	29·7532	53·769	5·24
1823	29·7920	47·230	6·12	1823	29·7846	46·071	7·19
Means..	29·8528	48·182	59·17	Means..	29·7566	48·928	60·92

Note.—The results for 1823 are calculated on the *year*, the observations in *Italics* are those which overpass the cycle: omitting these, the results of the year would stand as follows:—

Barometer .... 29·6995^{in}	Barometer .... 29·7780^{in}
Thermometer .. 49·0909°	Thermometer .. 51·3182°

The general results of the cycle are but little affected by this change, as will appear in the conclusion of the paper.

In the cycle of eight years and 312 days beginning with the moon in perigee, 27th December 1814, and ending 1st November 1823, there are comprehended 235 lunar apsides. On the day of the occurrence of each of these, according to the civil reckoning, I take, in the preceding Tables—1, the *mean height of the barometer* for the day, as shown by the curves traced on the face of Cumming's barometer clock in my possession; 2, the *mean temperature* of the twenty-four hours by Six's thermometer in the shade; 3, the *depth of rain* for the same and *the six following* days; 4, the direction of the *prevailing wind* as connected with each of the former three observations; the whole long since published *in detail* in my 'Climate of London.' In this work, under the head of "Periodical Variations," p. 197, vol. i., I hinted my being in possession of "some proofs of a peculiar relation between the moon's *apogee* and *perigee*, and the mean heights of the barometer on the days on

which they occur." I had thus carried the inquiry into three years of my own and two of Mr. Cumming's observations; and it regarded the barometrical variation alone: I have now extended it to a cycle of nine years, and made it include the other phænomena of temperature and rain, dependent in like manner, in this climate, on the direction of the wind: the following results will be found, I apprehend, of sufficient importance to claim the notice of the Society in addition to those I have already submitted to it, on the connexion of these several phænomena, in their periods and extent of variation, with the moon's *phase**.

1. *The barometer is higher under the apogee than under the perigee*: the cases *in detail* in which this occurs in the Tables, are as 66 to 48—the number of pairs of apsides examined being 114: the seven apsides not standing apposed to each other in the Tables afford on comparison the same result. The variation of the mean height proceeds under each apsis to the same *extent*, viz. about 1·58 inch; but the larger *range* belongs on the whole of the nine years to the perigee—the mean variation being then, apogee 0·9883 inches, perigee 1·1761 inch.

Of the nine *yearly mean results*, standing in the Summary at the end of these Tables [p. 28ª opposite], *seven* agree strictly with the rule. The year 1821 is an exception, to be further noticed: 1823 agrees as it stands, summed up with two pairs of apsides included, that overpass the cycle; but with these left out, we have apogee 29·6995, perigee 29·7780 inches, the exception going to nearly the same extent as in 1821. Of this last year, in which the height at the perigee exceeds (instead of falling short) by a tenth of an inch, I may remark that the difference in favour of the apogee in 1820 is extreme, amounting to a third of an inch (the mean of this apogee being also the highest, and that of the perigee the lowest of the series); and that if we take a mean betwixt this and the deficient one following (in 1821), we shall have a result agreeing with the rule—and the like of the perigee in each. There was therefore some peculiar cause influencing to a great extent the density of our atmosphere in that season, which may be made the subject of further inquiry in another place.

But the result on which I place the greatest dependence in proof of my main proposition, is the *mean for each apsis of the whole* of the observations included in the *cycle*, which is for the apogee 29·84517 inches, for the perigee 29·75542 inches, the apogee here exceeding by ·08975 inch.

2. *The mean temperature is lower under the apogee than under the perigee.* The range of the mean proceeds, as before, *to the same extent* under each apsis; but on

[* P. 19ª of the present collection.]

the whole the temperature is more variable (or of wider range) under the perigee, in the proportion of 36 to 32. The mean diurnal temperature is found at 32° or under, for the apogee *eleven times*, for the perigee *only six times*: and at 60° or above, for the apogee *twenty-two*, for the perigee *twenty-five times*. The cold extreme is therefore of much more probable occurrence under the higher apsis: but the proof of the main proposition must lie, as before, chiefly in the total results of the cycle.

The mean temperature, then, deduced from the whole of the observations put down, being 48·7126°, that of the apogee comes out 48·3885° and that of the perigee 49·0356°—the difference as to warmth in favour of the lower apsis amounting to ·6471°.

3. *The rain of the weeks following the apsis exceeds under the perigee; but with two striking exceptions in the annual result on nine years; the one in the wettest, the other in the driest year of the cycle.* These exceptions (which may perhaps be regarded as *compensation*) bring the two results so near to an equality (on the whole of the amount), that the apogee shows 59·17 inches, the perigee 60·92 inches, making 120·09 inches *thus noted*; but the whole rain of the cycle was 230·44 inches. Of the weeks taken to make up this amount of 120 inches, thirty-five are marked "Fair," as showing no rain by the gauge; of these twenty belong to the apogee and fifteen to the perigee.

If we examine the total results under the apogee in the third column of the Summary, we are struck with their symmetry. The *first* and *last* years of the cycle show *a mean quantity* of rain under this apsis; the remainder are found *in regular gradation*, from wet to dry, and back to wet again, thus 9·68, 6·89, 5·60, 4·32, 5·29, 6·50, 8·47. This will scarcely be accounted accidental by those who have attended to the subject, and who are aware of the many beautiful features of the kind which it presents. No such gradation appears in the results under the *perigee*, unless we choose to give that character to the five years from 1818 to 1822, which become wetter to 1820 and then drier again. It will be found, probably, that the rains under the higher apsis are determined by causes acting more extensively and more steadily, and thus more susceptible of this yearly increase and decrease from other causes than in the case of the lower apsis.

4. We come now to the influence of our attendant planet *on the winds of our climate*, and which (as before in the examination of these phænomena by the moon's *phase*) is found to constitute a key to the whole subject.

Winds from the north, north-east and east prevailed under the apogee on thirty-eight days, under the perigee on twenty-one days.

Winds from the south, south-east and west prevailed under the apogee on twenty days, under the perigee on thirty-eight days.

The winds from the south-west show thirty-one days for the higher, and but twenty-four for the lower apsis. In the remainder, and in the calm days, there is no marked preponderance; and if we class together the south-west and north-west with the *variable*, and divide the latter between them, the account shows an equal number for each.

The fair inference from the whole, on the concurrent evidence of the *vane*, the *barometer*, the *thermometer* and the *rain-gauge*, appears to be this,—That in the climate of London, as now treated of (and the precise or apparent limits of which we have yet to determine), the moon in her perigee brings over us the southern atmosphere, which, on the whole of the effects, tends to lower the density and raise the temperature of the air, occasioning also a larger precipitation of rain:

That the apogee, on the contrary, gives occasion to a freer influx of air from the northward, by which we obtain, on the whole of the effects, a higher barometer, with a lower temperature and less rain—subject still to an occasional compensation by a large addition to the rain under this apsis—and that, occurring twice in a cycle of nine years (at the times when also the extremes of wet and dry take place) upon the whole account of the year.

But the phænomena here exhibited cannot be finally appreciated without reference to the connexion of the *apsides* with the *phases* of the moon, and of both with the *declination*. I have treated this last cause already, and shown its effects on the density, temperature, winds and rain of our climate in the very dry year 1807, and the very wet one of 1816*; but I now purpose to resume the inquiry into its comparative influence through the cycle of nine years which I have in hand; and I may possibly be able also to treat briefly the subject of the combined effects of the three causes on the whole of the phænomena of our seasons, but in this I still feel that I greatly need the help of minds prepared by the requisite familiar acquaintance with astronomical science.

Tottenham, April 11, 1840.

[* See 'Climate of London,' vol. i. p. 181–197.]

ON A REMARKABLE DEPRESSION OF THE BAROMETER IN NOVEMBER 1840, AGREEING VERY CLOSELY IN ITS MOVEMENTS AND RESULTS WITH THAT OF DECEMBER 1821*.

The commencement of the present winter was attended with stormy weather, causing serious inundations and many shipwrecks; since which we have had a long and severe frost. The barometer showed in part of the months of October and November, in a remarkable degree, that rarefaction or loss of quantity in the European atmosphere, which is always more or less connected with these rapid and extensive movements: and there appears in nearly the whole of the phænomena a close correspondence with former atmospheric changes, in November and December 1821. Of these I gave an account to the Society in January 1822, which appeared in the Philosophical Transactions for that year, p. 113†.

On the 13th of November 1840, in the present case, the pencil of my clock barometer, after about thirty days of desultory variation tending downwards, had attained, at 8 P.M., the very low point of 28·03 inches. A very good upright barometer indicated at the same time 28·20 inches, which is probably nearer the true minimum, though I think rather above it. I have already stated elsewhere, that from the imperfect construction of the instrument the pencil on my clock ranges about 12 hundredths of an inch at each extreme *beyond the scale*,—a circumstance which however affects but little the results I am about to draw from its indications, as *compared with each other*. From the low point above mentioned, began a rise carrying the curve in twenty-four hours up to 29·10 inches; and in about twelve hours more it had reached 29·40 inches, or the part of the scale from which this rapid fall had commenced. A second depression of 8 tenths, and a corresponding elevation followed; after which the curve went up in two days by desultory movements to about 30 inches. From the 19th (where this occurs) to the 22nd we have another instance of rapid depression to below 29 inches, followed by as rapid a recovery. The movement then takes a bold swell of a week's continuance, carried up to 30·36 in., where we leave it; observing that the present results were obtained at Ackworth, Yorkshire, the former at Tottenham.

My first thought on discovering the barometer so near the bottom of the scale,

* Read before the Royal Society on the 11th of March, 1841. See Proceedings, No. 47 (vol. iv. p. 292).

[† Reprinted in the present collection, p. 13ª.]

Fig 1.

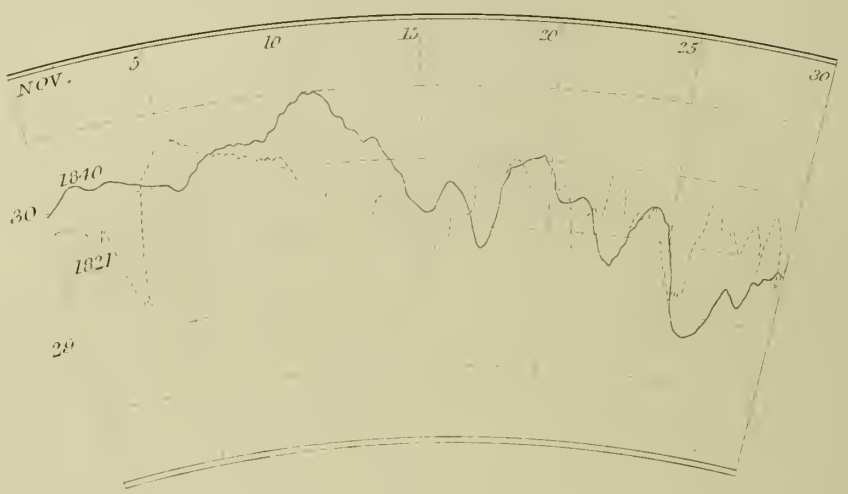
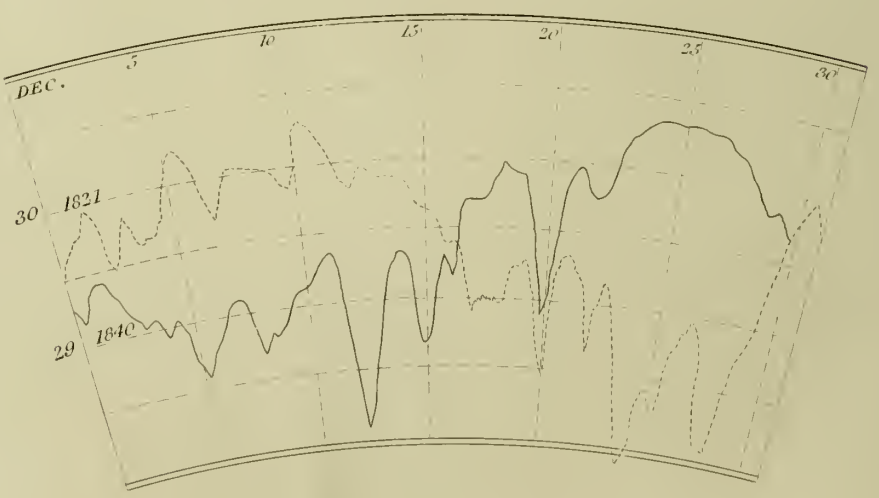

NOV.
5
10
15
20
25
30
1840
30
1821
29

Fig 2.


DEC.
5
10
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25
30
30
1821
29
1840

was to repeat the experiment I had made in 1821, in like circumstances, on the *boiling-point of water*. I found that with the vessel over the fire (the scale and all being immersed) I could not force the thermometer higher than 210°; and that on being removed from the fire it fell always at once to 209°. I attribute the difference of one degree to the *steam under pressure* diffusing heat through the actually boiling mass, and should call the real temperature 209°. The state of the barometer in which the boiling-point of thermometers is to be adjusted by the maker cannot be too strictly insisted on. For the level of London it might be well to fix it at 29·8 inches, another point being found for each higher station (*e.g.* Birmingham) lower in the scale.

I annex to this paper (pp. 37ª, 38ª) tables of the maxima and minima of the barometer, the prevailing wind and depth of rain measured for each day or other interval of October and November last, with the like for November and December 1821, a few notes of the weather being added; and that the reader may more easily compare them as regards the barometer, I have traced on the same scale (which is a copy of that on the face of the clock) the curves for the four months in question, repeating in a dotted line those I have before given for 1821. (See Plate IIª. figs. 1 and 2.) The reader must bear in mind, in making his comparison, that the crisis of the great depression falls earlier in the year by forty-two days in 1840 than in 1821.

In running the eye over the curves for October 1840 and November 1821, as here exhibited, he will doubtless be struck with a general likeness in character and extent in the two. Again, in those for the two following months, with some agreements of character and extent, there are bold contrasts in elevation. Leaving these, however, let us compare the actual continued depression and subsequent elevation in each year with the other.

The great depression of 1821 commenced from the high point of 30·32 inches, and was fourteen days in progress before it had reached the minimum of 27·80 inches. That of 1840, departing from a still higher one (or 30·54 inches), took thirty days' desultory movements to prepare for the final plunge of three days, in which it reached, and rose from, 28·03 inches. The recovery to 30 inches was in each case interrupted by a single large depression: in each case it occupied between six and seven days; and the fine upward sweep of the 28th to 31st December 1821 may be regarded as one of the most remarkable movements of the barometer we have on record.

The *winds* attending these variations, and which were doubtless more or less concerned as their immediate cause, I cannot on the present occasion undertake to investigate; but I shall point out something observable in the *rain*.

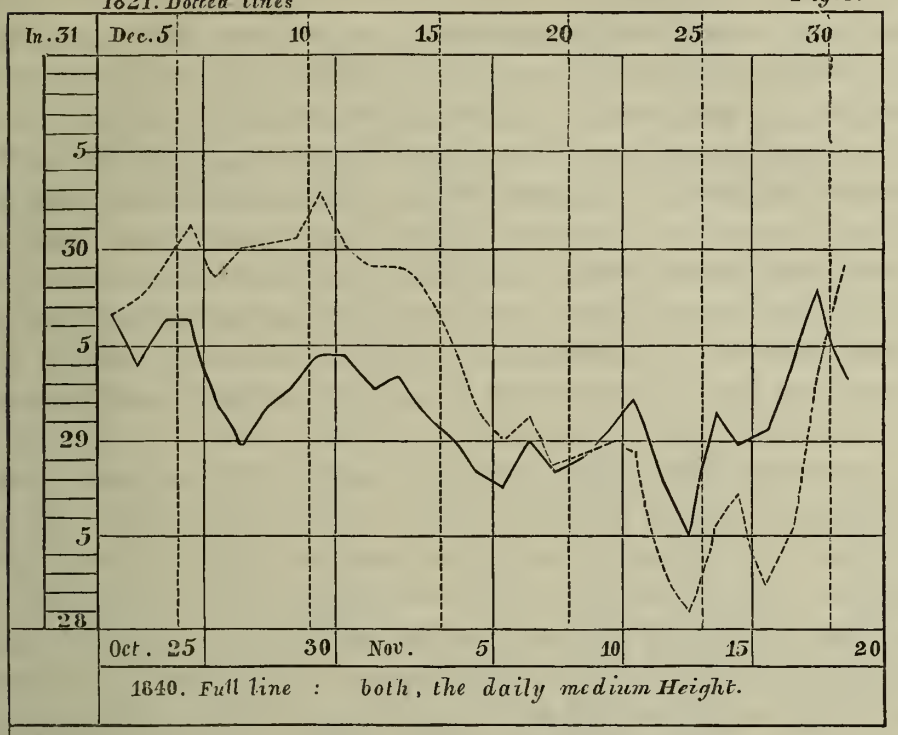
October 1840 was a *dry* month; mean of the barometer (at Ackworth) 29·834 inches, and the rain 1·19 inch. In 1821 this month was wet, and the one preceding the depression, November, wet in the extreme—the rain 4·67 inches. Thus it is not in the character, as wet or dry (or cold or warm), of the period going before that we are to seek for the cause of any great depression*. But in the two months *containing* those which I here compare, the agreement in the mean pressure and amount of precipitation is very striking. November 1840, mean of barometer (Ackworth) 29·41 inches, rain 4·27 inches. December 1821, mean of barometer (Tottenham) 29·38 inches, rain 4·85 inches. There was therefore in each about the same mixture of currents importing vapour into our climate with the opposite currents condensing it. See on this head, of the manner of production of our rains in wet seasons, Clim. Lond. i. pp. 117–129.

Being engaged at present in completing a paper for the Society, exhibiting a system of barometric averages ruled by the moon's place in declination†, I was led to try how far this cause might be concerned in producing (or determining as to time at least) the two great falls which I describe. The result has proved more striking than I had expected, the movements classing decidedly with those of the periods I had taken from the years 1807 and 1816 to exemplify this kind of variation in the "Climate of London." See vol. i. p. 183, and the Plate there. But as I exhibit a diagram of the present two, constructed upon the daily mean heights, I shall proceed to describe and remark upon them. See fig. 3 opposite.

* Nor is the subsequent weather necessarily connected with it. The mean temperature of January 1822, was 39°; of December 1840, 35°; that of February 1822, 42°; and of January 1841 [below 32°], with corresponding differences in other respects.

[† The succeeding paper of the present collection, p. 39ª.]

1821. Dotted lines *Fig. 3.*



1821. Moon on Eq: Dec. 3: North 9: Eq. 15-16: South 23: Eq. 30.

1840. —— on Eq: Oct. 22: South 29: Eq. 5-6: North 12: Eq. 18, Nov

L.H. inv.t et delt.

1840.

	in.		in.
Oct. 22.	29·670	Nov. 6.	28·750
23.	29·400	7.	29·000
24.	29·650	8.	28·865
25.	29·650	9.	28·900
26.	29·200	10.	29·065
27.	28·975	11.	29·225
28.	29·175	12.	28·825
29.	29·300	13.	28·515
30.	29·450	14.	29·170
31.	29·450	15.	28·990
Nov. 1.	29·285	16.	29·050
2.	29·350	17.	29·425
3.	29·130	18.	29·805
4.	29·000	19.	29·375
5.	28·840		

Mean of 28 days 29·165 inches.

1821.

	in.		in.
Dec. 3.	29·675	Dec. 18.	29·000
4.	29·750	19.	29·125
5.	29·900	20.	28·895
6.	30·125	21.	28·930
7.	29·850	22.	28·970
8.	29·990	23.	28·960
9.	30·010	24.	28·375
10.	30·055	25.	28·125
11.	30·285	26.	28·555
12.	29·985	27.	28·735
13.	29·890	28.	28·275
14.	29·890	29.	28·550
15.	29·765	30.	29·375
16.	29·520	31.	29·930
17.	29·150		

Mean of 28 days 29·346 inches.

The moon was on the equator, December 3rd, 1821, twenty-two days before the crisis of the great depression of the 25th; she was also on the equator, 22nd of October, 1840, twenty-two days before that of the great depression of November 13th. Taking this beginning, I have laid down on a scale of the barometer twenty-nine

days of variation of *the daily mean height* in each case, a method which very much simplifies the curve and helps the comparison. In the figure which I give, the full line is the variation of the mean from 22nd of October to 19th of November 1840; the dotted line, the same from 3rd to 31st of December 1821. It will be seen at once, that, thus placed together, the two variations agree (with each other and with the spaces of the period) in a manner which can be attributed to nothing (as the remote or ruling cause) but *the moon's change of place in declination*; and yet the effects have the appearance at first view of having been the result of opposite causes; for the crisis falls in 1840 with the moon in *full north*, and in 1821 with that planet in *full south* declination. Again, there is a swell in the curve of variation, in each case interrupting the continued descent, or rather preceding it, which corresponds in like manner with a south declination in 1840, and a north in 1821. Moreover, the two curves correspond in figure generally,—there is in each the same number of nearly simultaneous changes of direction, they set out at the beginning of the period from the same point, and return after the recovery very nearly to the same point of the scale again. The general mean of the curve belonging to 1840 is 29·189 inches; this mean line is crossed by that curve on the 13th day of the period, descending. The general mean of that in 1821 is 29·367 inches; this is crossed by the descending curve proper to it on the 14th day. And the curve for 1821, which descended lowest at the crisis, occupied a proportionately higher place in the scale where the continued descent begins.

With all these features of agreement at once with the assigned cause and with its period and division of time, I think no astronomer will be found hesitating as to the actual connection, but will at once pronounce these movements *an affair of lunar declination*, a problem which is to be investigated and solved on no other than astronomical principles. Should the fact strike him as a great discrepancy, that in one case the moon was approaching from the south during the fall of the barometer, and in high north declination at the crisis; in the other, receding southward and over a distant latitude on that side the equator at the time of the greatest manifestation of its power here,—let him reflect on the nature and movements of the great tidal wave in the ocean (following new and full moon alike), or (to take another familiar fact) consider the case of two observers of the time of high water in the Thames; the one at the river's mouth, the other at London Bridge. The winds may be (or they may not be) found a *principal mediate cause* of these variations, under the directing power of our attendant planet; but enough I think is even here exhibited to deserve the notice of our astronomers, and stimulate them to further inquiry on the subject.

October 1840.					November 1821.				
	Max.	Min.	Wind.	Rain.		Max.	Min.	Wind.	Rain.
	in.	in.		in.		in.	in.		in.
1.	30·10	29·90	W.		1.	29·86	29·81	S.W.	—
2.	30·14	30·10	W.		2.	29·84	29·70	W.	0·13
3.	30·10	30·07	W.		3.	29·70	29·20	W.	0·39
4.	30·10	30·04	N.	—	4.	30·10	29·20	W.	0·10
5.	30·04	30·00	N.		5.	30·30	30·10	W.	
6.	30·05	29·94	N.W.		6.	30·31	30·25	S.W.	
7.	30·17	30·05	N.		7.	30·25	30·16	E.	
8.	30·21	30·19	N.W.		8.	30·16	30·10	E.	
9.	30·23	30·19	N.W.		9.	30·10	30·07	E.	
10.	30·40	30·23	N.W.		10.	30·10	29·85	S.E.	
11.	30·54	30·40	N.W.		11.	29·85	29·65	S.	0·75
12.	30·54	30·34	W.		12.	29·98	29·80	W.	0·01
13.	30·34	30·16	S.W.		13.	29·92	29·60	E.	—
14.	30·19	29·95	S.W.		14.	29·24	29·15	S.W.	0·12
15.	29·95	29·65	S.W.		15.	29·65	29·30	S.W.	0·02
16.	29·86	29·64	W.	—	16.	29·55	29·26	S.W.	0·55
17.	29·87	29·50	N.W.	0·33	17.	29·75	29·55	S.W.	1·07
18.	29·75	29·36	N.W.		18.	30·11	29·55	N.	
19.	30·05	29·75	N.W.		19.	30·00	29·85	S.W.	0·28
20.	30·08	30·00	N.W.		20.	29·93	29·50	S.W.	0·07
21.	30·00	29·75			21.	29·85	29·40	N.W.	0·09
22.	29·80	29·50			22.	29·70	29·35	S.W.	0·03
23.	29·50	29·36			23.	30·00	29·70	S.W.	0·15
24.	29·79	29·50	N.W.		24.	29·70	29·55	S.W.	—
25.	29·79	29·50	W.		25.	29·73	29·25	N.W.	1·25
26.	29·50	28·90	N.W.	0·37	26.	29·40	29·05	S.W.	0·32
27.	29·05	28·90	N.E.		27.	29·82	29·40	N.W.	
28.	29·30	29·05	N.E.	—	28.	29·75	29·34	S.W.	0·04
29.	29·40	29·18	S.E.	—	29.	29·80	29·38	S.W.	0·14
30.	29·49	29·40	S.E.	0·49	30.	29·83	29·23	N.W.	0·16
31.	29·55	29·33	S.E.						
Mean .... 29·834 in. Rain 1·19 in.					Mean .... 29·725 in. Rain 4·67 in.				

1840. October 7–12, a sharp frost, which cut off the more tender plants: 18, 19, high wind: 24–27, hail showers, cold wind, frost.

1821. November 3, very stormy night: 4, stormy: 16, squally: 20, all the marshes in the neighbourhood flooded by the late rains: 25–30, stormy nights.

November 1840.					December 1821.				
	Max.	Min.	Wind.	Rain.		Max.	Min.	Wind.	Rain.
	in.	in.		in.		in.	in.		in.
1.	29·40	29·15	S.E.		1.	29·80	29·50	W.	0·03
2.	29·44	29·25	N.E.		2.	30·00	29·70	W.	—
3.	29·25	29·00	E.		3.	29·85	29·50	S.W.	0·80
4.	29·08	28·92	S.E.		4.	29·85	29·65	N.W.	0·15
5.	29·06	28·60	S.	—	5.	30·12	29·68	W.	0·09
6.	28·90	28·59	S.E.	0·70	6.	30·25	30·00	N.W.	
7.	29·09	28·90	S.W.		7.	30·00	29·70	S.E.	—
8.	29·07	28·66	W.		8.	30·05	29·93	W.	—
9.	29·00	28·80	W.	0·37	9.	30·04	29·98	S.W.	0·02
10.	29·10	29·00	W.		10.	30·25	29·86	S.	0·03
11.	29·35	29·10	W.		11.	30·32	30·25	N.W.	
12.	29·34	28·10	S.		12.	30·15	29·82	S.E.	
13.	28·90	28·03	S.E.	1·37	13.	29·95	29·83	S.E.	—
14.	29·34	28·90	W.		14.	29·90	29·88	S.	0·03
15.	29·34	28·65	W.		15.	29·86	29·65	S.E.	
16.	29·35	28·75	S.W.	0·91	16.	29·65	29·39	S.W.	—
17.	29·71	29·15	S.E.	0·63	17.	29·40	28·90	S.W.	0·48
18.	29·94	29·67	W.		18.	29·02	28·98	S.W.	0·11
19.	29·98	29·88	N.W.		19.	29·27	28·98	S.W.	0·06
20.	29·88	28·88	S.W.		20.	29·30	28·49	S.W.	0·31
21.	29·93	29·00	N.W.	0·29	21.	29·35	28·49	N.W.	0·03
22.	29·94	29·72	N.W.		22.	29·35	28·59	S.W.	0·26
23.	29·98	29·89	N.W.		23.	29·17	28·75	W.	0·08
24.	30·34	30·20	N.W.		24.	28·85	27·80	S.	0·78
25.	30·36	30·33	S.W.		25.	28·45	27·89	N.W.	
26.	30·34	30·30	N.W.		26.	28·86	28·25	E.	0·35
27.	30·30	30·17	N.W.		27.	28·97	28·50	S.W.	0·35
28.	30·17	29·90	S.		28.	28·50	28·05	S.E.	0·68
29.	29·90	29·80	S.		29.	28·95	28·15	N.W.	0·18
30.	29·85	29·68	S.W.		30.	29·80	28·95	S.E.	0·03
					31.	30·00	29·70	N.W.	
Mean.... 29·410 in. Rain 4·27 in.					Mean.... 29·385 in. Rain 4·85 in.				

[1821. Nov. continued.]—Daniell's Hygrometer, at noon, indicated on the 7th a depression of 15°, on the 8th of 9°, on the 9th of 10°, and on the 10th of 5°. This gradual approach in the air to the point of saturation occurred during the few fine days of the period.

1840. November 13, this great fall of rain, with a high wind, began about 4 A.M. and continued, with very little intermission, till 8 P.M., when the wind came round to the west: 16, 17, again heavy rain: 25–28, frost.

1821. December 5, showers, with thunder P.M.: 17, night squally: 20, heavy showers at intervals through the day; night stormy, with lightning: 25, very fine day: 26, 27, rainy, some hail: 28, rainy, sleet about half-past one P.M. "The barometer at Epping was, at midnight on the 24th, 27·76 inches; at 6 A.M. 25th, 27·73 inches. Tho. Squire."

Tottenham, January 30, 1841.

ON A CYCLE OF EIGHTEEN YEARS IN THE MEAN ANNUAL HEIGHT OF THE BAROMETER IN THE CLIMATE OF LONDON, AND ON A CONSTANT VARIATION OF THE BAROMETRICAL MEAN ACCORDING TO THE MOON'S DECLINATION*.

I HAVE already treated this subject, partially and in detail, in the 'Climate of London†.' The further and full development of it in that way will be found an undertaking more of labour than of difficulty, the materials being already provided for doing this through a lunar cycle of eighteen years; but I am enabled, by means of these, to present to the Royal Society some general results, which will prove interesting, and probably important to the science to which they belong.

The like method has been adopted in this paper as in my two former, read before the Society, on the connexion of the barometric variation with the *Lunar Phases* and *Apsides*‡. I have excluded, by appropriate averages, those effects of the lunar influence which belong not to the subject immediately before us. These, however, will require, whensoever we may think it time to form a theory, to be examined conjointly with the present and every other of the elements of this intricate subject.

[The Tables of Barometrical Averages, from which the results stated in this paper are deduced, now follow, on the next page.]

* Reprinted from the Philosophical Transactions for 1841, p. 277, having been received by the Royal Society on the 4th of February, and read on the 11th of March in that year.

† Vol. i. p. 172. 2nd edition.

[‡ Pp. 19ª and 23ª of the present collection.]

Table I.

Barometrical Averages on successive Solar Years, from 1815 to 1832, constructed to show the Moon's influence on the Mean Heights, varying according to her Declination: for the manner of forming which see the remainder of this paper.

Year.	Days' observations.	Annual Mean.	Moon in or near the equator.	Moon at or near her greatest north declination.	Moon in or near the equator.	Moon at or near her greatest south declination.	Averages on nine years.
		in.	in.	in.	in.	in.	in.
1815	370	29·766	29·8391	29·7819	29·7947	29·8880	
1816	368	29·648	29·7883	29·7128	29·7046	29·8357	
1817	362	29·733	29·7908	29·8590	29·8420	29·7499	
1818	369	29·826	29·8116	29·8649	29·8363	29·8348	
1819	361	29·831	29·7930	29·8168	29·9287	29·7106	
1820	369	29·839	29·8014	29·8020	29·9363	29·8622	
1821	362	29·805	29·8206	29·9085	29·7880	29·7044	
1822	362	29·889	29·8543	29·8472	29·9354	29·9426	
1823	369	29·763	29·8040	29·8436	29·6741	29·7203	
1824	368	29·878	29·9788	29·9126	29·9129	29·7546	29·8111
1825	362	29·987	30·0823	30·0285	29·8932	29·9933	29·8235
1826	369	30·033	30·0899	30·0213	29·9959	29·9910	29·8501
1827	362	29·938	29·9374	29·8875	29·9218	29·9829	29·8723
1828	363	29·814	29·8590	29·7832	29·7990	29·8608	29·8848
1829	363	29·688	29·6838	29·6563	29·6857	29·7002	29·8829
1830	368	29·671	29·7404	29·6902	29·6604	29·6900	29·8661
1831	362	29·653	29·6351	29·6310	29·6700	29·5968	29·8512
1832	363	29·702	29·6480	29·8210	29·7293	29·6830	29·8250

The averages on successive periods of nine years in the last column exhibit the barometrical mean, increasing and decreasing, as follows:—29·8111 + 0124 + 0266 +0222 + 0125 = 29·8848 − 0019 − 0168 − 0149 − 0262 = 29·8250 inch. Then, to complete the cycle, 29·8250 − 0139 =29·8111 inch.

Table II.

Barometrical Averages on successive Cycles of nine Solar Years, classed according to the Moon's place in Declination.

Periods taken.	1. Moon at or near equator, and going north.	2. Moon at or near her greatest north declination.	3. Moon at or near equator, and going south.	4. Moon at or near her greatest south declination.	5. Averages on whole periods of nine years.	6. Averages on the four results preceding.
	in.	in.	in.	in.	in.	in.
1815–23	29·8114	29·8263	29·8267	29·8054	29·8173	29·8174
1816–24	29·8270	29·8408	29·8398	29·7794	29·8059	29·8218
1817–25	29·8596	29·8759	29·8608	29·8081	29·8366	29·8511
1818–26	29·8929	29·8939	29·8779	29·8349	29·8577	29·8749
1819–27	29·9069	29·8964	29·8873	29·8513	29·8696	29·8856
1820–28	29·9142	29·8927	29·8729	29·8680	29·8691	29·8870
1821–29	29·9011	29·8765	29·8451	29·8500	29·8518	29·8682
1822–30	29·8922	29·8523	29·8304	29·8484	29·8372	29·8560
1823–31	29·8678	29·8282	29·8014	29·8100	29·8123	29·8269
1824–32	29·8505	29·8257	29·8076	29·8058	29·8076	29·8225
Mean by the columns.	29·8724	29·8608	29·8450	29·8261	29·8365	29·8511

The averages presented at the foot of columns 1 to 4, show a decrease in the barometrical mean, consequent on the moon's varying positions in declination, which may be thus stated: 29·8724 in. on equator, *minus* by north place, ·0116 in.; again, *minus* by passage of equator south, ·0158 in.; again, *minus* by south place, ·0189 in.; lastly, *plus* by return north over equator, ·0463 in.

The averages in columns 5 and 6 exhibit the barometrical mean, increasing and decreasing with great regularity, during the course of a lunar cycle of eighteen years.

The averages which form the two tables before us were obtained in the following manner:—

1. The *year* was divided, by an ephemeris, into periods of lunar declination, the whole set in each case including not less than 361, nor more than 370 days.

2. These periods of declination were subdivided into *weeks* (or spaces of from six to eight days, generally *seven*) with the moon's extreme north, her extreme south, and her respective positions on the equator, coming and going, placed as nearly as might be *in the midst of the space* on which the average was taken—to wit, the average of the *medium heights* of the barometer for each twenty-four hours of the space.

3. These weekly averages, obtained generally from the curves inscribed by the barometer, on the face of a clock by Cumming, in my possession, were then placed under their respective heads of the four positions of the moon above-mentioned.

4. They were then laid together for the whole year, or for the number of days necessarily so accounted, which numbers make an average of $365\frac{1}{3}$ days to the year.

5. Averages were, lastly, taken under the respective heads of north, south, &c. on successive *periods of nine years*, as 1815–23, 1816–24, &c., the series beginning 23rd December 1814, and ending 19th December 1832. These results occupy the four leading columns of the second Table; the preceding are in Table I.

6. The leading column in Table I. contains a set of *annual barometrical means* taken (with the exception of the last) from those I have already published in the 'Climate of London.' These are calculated from the Tables for each month in the ordinary way, and not on the solar years. I have given them as they stand in that work, though in the years from 1815 to 1817 they ought possibly to be higher by a tenth of an inch, from the too high placing the scale in those years; but this (with other like inaccuracies which may be hereafter found and rectified) I do not consider as affecting much *the proportions found among the results in any given year.* In calculating the set of averages on periods of nine years, placed in the last column of this Table, I have, however, to prevent discrepancies, *added* this tenth of an inch upon each of the three years.

7. The fifth column of Table II. contains the barometrical mean, calculated upon the whole period of solar years, which, in the four preceding columns, are averaged under the respective lunar positions of north, south, &c. The sixth column of this Table shows a mean founded on a direct average of the four results placed under these heads. I have noticed some features of the variation at the foot of the Tables. I shall proceed now to state some general results, of course as to the barometer alone. The effects on the mean temperature and rain must for the present be left unnoticed*.

The barometrical mean in our climate is depressed (on an average of years) by the moon's position in south declination.

In every one of these averages upon periods of nine years, in Table II., the mean under *south* is lower than that under *north* declination; the difference being in some cases between six and seven hundredths of an inch: and it is larger on the averages in the fore-part than on those in the latter part of the series.

The mean under *south* declination is also *lower than either of the other three*; with exception of the four latter averages, in which it exceeds a little that of the position "going south."

This depression is gradual: it commences with the moon in full *north* declination, and proceeds through her remaining positions to the time when she again crosses the equator to return north; at which season the whole weight that had been abstracted is suddenly restored—this of course must be understood of the small differences in the mean here treated. There will be found, in the observations employed, an abundance of particular cases of variation which contradict such a rule, but the *compensations*, it appears, cover these in its favour.

We have here, I think, evidence of a great *tidal wave* or swell in the atmosphere, caused by the moon's attraction, preceding her in her approach to us, and following slowly as she departs from these latitudes. Were the atmosphere a calm fluid ocean of air of uniform temperature, this tide would be manifested with as great regularity as are those of the ocean of waters. But the currents, uniformly kept up by the sun's varying influence, effectually prevent this, and so complicate the problem.

There is also manifest in the lunar influence *a gradation of effects*, which is here shown, as it is found to operate *through a cycle of eighteen years*. In these, the mean weight of our atmosphere increases through the fore-part of the period; and, having kept for a year at the maximum it has attained, decreases again through the remain-

[* They are discussed in the succeeding paper, p. 43ª.]

ing years to a minimum; about which there seems to be some fluctuation, before the mean begins to rise again.

This result is brought out in different ways by all the averages upon *years*; and it pervades, though with less of uniformity, those upon the quarter periods or *weeks* of declination. The study of these, *with a view to theory*, rude and imperfect as they are, may become, I would willingly hope, an occupation for those more capable and better prepared than myself to grapple with the subject.

L. H.

February 3, 1841.

ON THE PROPORTIONS OF THE PREVAILING WINDS, THE MEAN TEMPERATURE, AND DEPTH OF RAIN, IN THE CLIMATE OF LONDON; COMPUTED THROUGH A CYCLE OF EIGHTEEN YEARS ON PERIODS OF THE MOON'S DECLINATION*.

In the paper now offered, I am about to do that for the periodical variations of the winds, rain and temperature, which I have already done for those of the barometer, as regards their connection with the lunar declination. I shall begin with some *mean* and *total results* calculated upon a period of years extending from 1815 to 1832.

1. *Of the Proportions of the Winds.*

In my work on the 'Climate of London' (first printed in 1818 and 1820), I stated the proportions of the opposite winds, for 365 days, on the ten years from 1807 to 1816 as follows, viz. easterly 140, westerly 225, northerly 192, southerly 173. And on the seven years from 1817 to 1823 (2nd edit.), easterly 138, westerly 227, northerly 195, southerly 170; the few noted *variable* being divided proportionably to the rest. By the present investigation (the variable being divided as before), the numbers stand thus: easterly 136, westerly 229, northerly 199, southerly 166. Thus, on the broad scale, and in examining successive periods of years,

* Read before the Royal Society on the 22nd and 29th of April 1841. See Proceedings, No. 47 (vol. iv.), pp. 299, 300.

there should seem to have been a slight falling off of the *easterly* and *southerly*, with a proportionate increase of the *westerly* and *northerly*, in these twenty-five years. I have given in that work again the proportions of the winds for each year, as distributed in four classes, as follows:—1. N. and N.E.; 2. E. and S.E.; 3. S. and S.W.; 4. W. and N.W.: these I shall, for brevity's sake here, only refer to; but it may be proper to state the proportions as they come out by the present calculation upon eighteen years.

	N.–E.	E.–S.	S.–W.	W.–N.	
1815.	83	45	120	117	Dry.
1816.	69	71	118	108	Wet.
1817.	84	54	122	105	
1818.	72	87	117	89	
1819.	79	59	95	132	
1820.	88	60	95	123	Dry.
1821.	62	61	106	136	Wet.
1822.	81	57	115	112	Dry.
1823.	71	63	101	130	
1824.	87	48	96	135	Wet.
1825.	70	64	96	135	Dry.
1826.	74	79	80	132	Dry.
1827.	56	64	106	139	
1828.	38	77	104	147	Wet.
1829.	62	83	71	149	
1830.	46	70	90	159	
1831.	69	70	82	144	Wet.
1832.	60	81	94	131	Dry.

Note.—Those years are marked in which the rain on the whole year considerably exceeded or fell short of the average. It will be seen that the *proportions* merely do not decide *the wet or dry character* of a whole year.

The near coincidence of the averages on successive periods of years, and the pretty narrow limits of the variation of numbers in each class in the separate years, may satisfy us that there exists a *systematic distribution* of the winds in our climate. This, as here exhibited, is probably due to solar influence, and to the same general causes which regulate the constant changes of the seasons throughout the year. But the present inquiry goes further, and relates to the possible modification, from

year to year also, through a lunar cycle, of these proportions *by the varying attractions of our attendant planet.*

The General Table (the first in the *Synopsis* at the end, p. 61ª) exhibits these variations, calculated in detail upon weeks of lunar declination (see the Tables, No. 1 to 18) in the manner used in my former papers; the positions in extreme north or south or *on* the equator going either way, being taken as the middle of the period computed upon. The careful study of these averages, in connexion with similar ones upon the phases and apsides, may lead hereafter to some useful results: we may even be able by these means to assign to the different lunar aspects beforehand *the winds that shall attend them.* Viewed as they stand here, they present (as do the Tables at large) many striking coincidences and differences, with some tendency also to a gradation of increase and decrease from year to year, which is a feature of the science. From the hasty view I have as yet been able to take of them, it should seem,—

1. That a *north-east* wind is most promoted by the constant solar influence (which causes it) when the moon is about the equator going *south.*

2. That a *south-east* wind in like manner prevails most with the moon proceeding to *south* declination.

3. That winds from the *south and west* blow more with the planet in its *mean degrees of declination* going either way, than with a full north or south declination.

4. That a *north-west wind* (the common summer and fair-weather wind of the climate) affects in like manner the *mean declination* in either direction, in preference to the north or south; and most when the planet is coming *north.*

The opposite classes of winds in their respective yearly proportions are as follows; the variable and calm days being divided.

	Southerly.	Northerly.	Westerly.	Easterly.	
1815.	164	201	237	128	Dry.
1816.	189	177	227	139	Wet.
1817.	176	189	228	137	
1818.	205	160	206	159	
1819.	159	211	227	138	
1820.	155	211	217	149	Dry.
1821.	167	198	243	122	Wet.
1822.	171	194	227	139	Dry.
1823.	164	201	231	134	
1824.	145	221	230	136	Wet.
1825.	161	204	230	135	Dry.
1826.	159	206	212	153	Dry.
1827.	169	196	245	120	
1828.	176	190	248	118	Wet.
1829.	153	212	221	144	
1830.	160	205	249	116	
1831.	151	214	226	139	Wet.
1832.	174	192	225	141	Dry.
Averages.	166	199	229	136	

Note.—The winds, as stated in this table, have reference to the year by the calendar, and to their estimated proportions in 365 or 366 days only.

2. *Of the Rains as distributed through the Periods.*

I have stated the annual average depth of rain falling about London, as collected by my own and assistant's gauges in the years from 1807 to 1819, to be 24·87 inches (Clim. Lond. 2nd edit. i. 101). Adding however to these the previous years from 1797 to 1806, as found in the register of the Royal Society, and making the correction necessary on account of the elevation above the ground of the gauge at Somerset House (and, in part, of my own at Plaistow), the average rain of twenty-three years comes out at 25·18 inches. Again, prolonging the period to 1830, we have 25·13 inches; and further, on the whole period on which I have any good account of the fall about London, extending to 1839, and making forty-three years, *the annual average is found to be* 25·17 *inches*. The near agreement of the latter results

with each other may warrant the conclusion that we have now ascertained satisfactorily *the annual average fall of rain at the surface of the earth for the neighbourhood of London.*

The average of the eighteen years here used comes out however 25·61 inches; which, though probably less accurate as regards the *climate*, is sufficiently so for our present purpose of examining *the distribution*, which is as follows :—

	in.
In the weeks with the moon in south declination . . .	6·67
In the weeks with the moon coming north	6·47
In the weeks with the moon in north declination . . .	6·42
In the weeks with the moon going south	6·05
	25·61

The rain of our climate appears then to be affected in its quantity by the moon's position in declination: and the manner of this distribution is such, that there falls most rain (by measure and at the surface of the earth) in the weeks in which she is south of the equator; and least when she is passing over it southward; the full north declination, and the weeks in which she is approaching towards it, having a mean quantity. The differences are small, but they are the more likely on this account to be real and constant in successive cycles of years.

Again, as to the connexion of the rain with *thunder*, we have—

Under south declination 33 cases in eighteen years.
Under the moon coming north 35 cases in eighteen years.
Under north declination 27 cases, and
Under moon going south 28 cases in eighteen years.

The atmosphere of our climate is therefore sensibly more subject to electrical accumulation in the clouds, and to discharges consequent on this degree of tension, at those times when the moon is either south of the equator, or returning from that position.

We need not go farther for the cause of *the small excess of rain in these weeks*; and it may very possibly be found that this state of things coincides with a *greater calmness in the air*; the rapid interchange of currents appearing to be one means of the mixture of the vaporous with colder air, and the easy precipitation of the products of this condensation.

3. *Of the Temperature as connected with the Periods.*

The climatic annual mean temperature, as found by computation of the data contained in the General Table in the annexed Synopsis (p. 61ª), is 49°·51. This is just a medium between the London and country mean temperatures given in the 'Climate of London,' see vol. i. p. 5. The distribution of this among the several classes of lunar declination, on which my inquiry proceeds, is as follows:—

For the weeks under south declination	49·36°
For the weeks under the moon coming north . .	49·71
For the weeks under north declination	49·58
For the weeks under the moon going south . .	49·40

The differences are again small: and it might be reasonably objected, that they are quite as likely to arise from accident, as from a cause concerned in our cold or heat, as is the moon's attraction; but let us first view them separately, and in connexion. It is not like the effect of accident that they should be found to make a *gradation of results*, beginning with that under south declination: thus 49°—·36, ·40, ·58, ·71; the mean being highest while the moon is crossing the equator towards these northern latitudes, and decreasing through the three remaining positions to its lowest in the south: and the differences are not greater than a small variation in the pressure might produce.

Here again we may have recourse to collateral effects in our atmosphere, in proof of *the tendency to warmth or coldness* thus brought on. Of the weeks under *south declination*, those which may from the mean be pronounced *frosty*, are . . 20

With the moon *coming north* they are	12
With the moon in *north declination*	15
With the moon *going south* (again)	20

Thus we have, with the lowest mean temperature, the greatest number of frosty weeks, and, *vice versâ*, with the highest mean the fewest of these. The effect in bringing on *frost* seems to be more suddenly produced than is the lowering of the weekly mean at other seasons (perhaps from radiation into space); hence we have a maximum number of frosty weeks, also, in the time that the moon, having passed a week in north declination, is going over the equator south. The difference here is very palpable, as in the case of thunder-storms before. It should appear from these facts—

1. That the pressure of an atmospheric tide, which attends the approach of the moon to these latitudes, is capable of *raising* the mean temperature 0·35 of a degree.

2. That the rarefaction under the moon in north declination is capable of lowering the temperature 0·13 of a degree.

3. That the northerly swell following the planet as she recedes to the south, cools the air further 0·18 of a degree.

4. That this cold continues while the moon is away south, reducing the mean temperature yet lower by 0·04 of a degree. It remains to be seen (provided further investigation should confirm the facts here stated) what part of the *rise* of the mean may be due to the translation of air from the south, and what to the pressure of a *tide*. Again, in the *depression* of the mean, how much cold we may ascribe to rarefaction, and how much to an actual *infusion* of northern air into our climate. We find on the whole a *warmth* equal on the average to 0·36 of a degree connected with the moon's *approach to us in declination*, and a *cold* of equal amount finally resulting from her *going away to the south*.

The whole of these results are drawn from the calculations on weekly periods contained in the eighteen years' Tables annexed to this paper; and these again chiefly from observations long since published. I am not conscious of having anywhere displaced a day or changed a figure in favour of a preconceived hypothesis. I have been led to bestow the greatest portion of my labour on the connexion of the phænomena with the *declination*, because I consider it to have the most palpable influence on the climate; but there remains yet a sufficiently laborious task, in examining how far and in what way the several elements of this extended problem—the *phase*, the *apsis* and the *declination*—affect each the influence of the other. And until this be done, it will not be safe to draw general conclusions. But that the solar influence, to which we owe our seasons, and which is the prime mover of the winds in all climates, is so modified in our own by the effects of the varying lunar attraction, must now be admitted on the evidence of plain facts. The pressure and temperature of the atmosphere, the deposition of rain, and in all probability the radiation and the electricity, are subject in measure to this influence: which is therefore highly deserving of a more accurate and minute investigation than myself or any single observer can be expected to bestow upon it. The first step in this pursuit appears to me to be the verification of the observations and results, with which view I have submitted the whole to the notice of the Society.

To a *student* in meteorology these tables will be found of much interest. He may

trace by their means the connexion of fair weather, rains, thunder, frosty seasons, &c., with the attendant and prevailing winds and temperatures; and if he refer back upon occasion also to the register itself, he cannot fail to acquire considerable insight into the peculiarities of our climate.

Tottenham, 31st March, 1841.

Preface to the Tables.

The *divisions* headed "south," &c. comprise portions of time usually of seven days, sometimes of six or eight, dividing the moon's whole period of declination into four weeks; *in the midst of each of which* she is to be taken as in full south or full north declination, or on the equator going north or south. The extent of the four is determined by the dates in the first column.

The *wind* noted for the week is usually that which has most prevailed; but this is sometimes departed from to preserve the succession of different winds, and the occurrence (even for a day) of winds deemed critical and important.

The *temperature* is the *mean*, including day and night, of the whole of the week in question.

The *rain* is that which was afforded by the gauge during the week. In a very few cases it was found needful to divide between two weeks, by estimate, the whole or some part of the result.

The *mean* and *total* results at the foot will be found applied to use in the General Table or Synopsis, p. 61ª. A mark (†) is put to those amounts of rain which were found connected with thunder, and those weeks are also distinguished [by the degrees of mean temperature being given in old numerals underlined] which from the temperature by day and night may be designated *frosty**.

* [The diagrams which accompanied this paper, as communicated to the Royal Society, are now omitted, together with the paragraphs relating to them; but the author has substituted for two of them, in the Synopsis, p. 61ª, new diagrams of the Yearly Mean Temperature and Yearly Rain.]

The Winds, Temperature and Rain by the Moon's Declination.

TABLE I.—1815.

	South decl.			Mean decl.			North decl.			Mean decl.		
	Wd.	M. temp.	Rn.	Wd.	M. temp.	Rn.	Wd.	M. temp.	Rn.	Wd.	M. temp.	Rn.
		degr.	in.		degr.	in.		degr.	in.		degr.	in.
Dec. 23–Jan. 5 ..	..	....	..	..	....	..	E'ly	34·85	1·32	N'ly	34·50	0·09
Jan. 6–Feb. 2....	N.W.	32·85	..	N.	33·21	0·28	N.E.	28·43	..	S.W.	38·78	0·79
Feb. 3–Mar. 1 ..	Var.	43·93	0·32	S.W.	44·83	0·36	W'ly	46·28	0·44	S.E.	43·28	0·06
Mar. 2–28	W'ly	44·64	0·53	W'ly	41·78	0·94†	W'ly	51·42	0·19	S.W.	50·07	0·67
Mar. 29–Apr. 24 .	Var.	52·28	0·06	W'ly	53·57	0·50	N'ly	44·50	0·27†	Var.	45·66	1·10
Apr. 25–May 22 .	E'ly	50·28	0·16	N.E.	58·28	0·27†	S.W.	57·71	0·52†	N.W.	57·78	0·02
May 23–June 18 .	N.E.	60·57	0·29	W'ly	60·57	0·24	S.E.	57·83	0·29†	S.W.	60·43	1·20†
June 19–July 15 .	N'ly	60·57	0·12†	W'ly	61·21	..	Var.	58·57	0·11	S.W.	65·42	
July 16–Aug. 12 .	W.	61·21	1·00	N.W.	60·21	0·27	N.E.	62·71	0·02	N.W.	58·86	0·47†
Aug. 13–Sept. 8 .	W'ly	63·75	0·72†	Var.	63·00	0·86†	S.W.	60·86	0·21	W'ly	54·50	0·06
Sept. 9–Oct. 5 ..	S.E.	59·07	..	S'ly	57·21	0·20	S'ly	50·64	0·96	S'ly	51·33	0·30
Oct. 6–Nov. 2 ..	N.W.	48·00	1·04	S'ly	52·71	0·39	S.W.	49·14	0·49	N.E.	46·14	0·61
Nov. 3–29	S.W.	42·86	0·50	N.W.	42·36	0·86	N'ly	31·86	..	N'ly	33·25	
Nov. 30–Dec. 27 .	S'ly	43·57	1·00	N'ly	32·00	..	S.W.	36·43	1·12	S.W.	33·64	
Mean.....	..	51·04	5·74	..	50·84	5·17	..	47·94	5·94	..	48·12	5·37

TABLE II.—1816.

Dec. 28–Jan. 23..	W'ly	35·00	0·39	S.W.	40·57	0·69	S'ly	38·00	0·95	S'ly	36·86	0·31
Jan. 24–Feb. 19..	N.E.	33·43	0·20	S'ly	34·36	0·40	N'ly	21·21	1·38	Var.	36·17	0·07
Feb. 20–Mar. 18 .	S.W.	41·07	0·16	W'ly	35·36	0·64	Var.	38·50	1·18	W'ly	43·00	0·48
Mar. 19–Apr. 14 .	N.W.	39·92	0·03	N.E.	37·14	..	S.E.	38·36	0·47†	N'ly	39·86	1·08
Apr. 15–May 11 .	S.E.	44·50	0·01	E'ly	54·71	0·32	N.W.	50·00	0·45	S.W.	47·83	1·05
May 12–June 8 ..	Var.	49·50	0·09	N.E.	51·36	0·20	S'ly	57·71	0·28	N.	55·28	0·47
June 9–July 5 ..	Var.	52·65	0·31	S.W.	60·91	..	N.E.	60·57	3·11	W'ly	59·16	0·50
July 6–Aug. 1 ..	S.	60·43	0·31	W'ly	56·36	1·53	W'ly	63·00	0·82†	N.W.	55·42	0·3†
Aug. 2–28	S.W.	61·00	0·84	S.E.	61·64	0·43	N.W.	57·50	0·34	N.E.	57·50	
Aug. 29–Sept. 25 .	S.E.	50·15	2·24	S.W.	55·30	0·91	N.E.	57·14	..	E'ly	54·57	0·13
Sept. 26–Oct. 22 .	S.W.	53·87	1·25	E.	58·57	0·97†	N'ly	51·17	..	S.E.	44·36	0·34
Oct. 23–Nov. 18 .	S.E.	45·21	0·54	S'ly	45·14	1·78	N.W.	36·36	0·89	W'ly	36·50	0·07
Nov. 19–Dec. 17 .	Var.	33·78	—	N.	35·30	0·41	E'ly	35·36	0·67	S.W.	37·00	1·05†
Dec. 18–29.....	N'ly	30·50	0·20	W'ly	36·86	0·65						
Mean.....	..	45·00	6·57	..	47·39	8·93	..	46·53	10·54	..	46·42	5·28

Table III.—1817.

	South decl.			Mean decl.			North decl.			Mean decl.		
	Wd.	M. temp.	Rn.	Wd.	M. temp.	Rn.	Wd.	M. temp.	Rn.	Wd.	M. temp.	Rn.
		degr.	in.		degr.	in.		degr.	in.		degr.	in.
Dec. 30–Jan. 12..	..	....	..	....	....	..	s'ly	40·78	3·70	Var.	30·14	0·14
Jan. 13–Feb. 8 ..	s'ly	35·57	1·17	s.w.	44·07	0·09	w'ly	42·57	0·06	w'ly	43·75	0·06
Feb. 9–Mar. 8 ..	Var.	41·78	0·86	s.w.	42·14	0·09	w'ly	44·14	0·28	w'ly	39·14	1·44
Mar. 9–Apr. 4 ..	w'ly	43·42	0·01	E'ly	35·64	..	Var.	39·93	0·24	Var.	46·71	
Apr. 5–May 2 ..	N'ly	39·57	0·01	N.W.	44·28	0·08	N.E.	43·21	0·05	N'ly	43·86	0·10
May 3–29	Var.	50·58	0·12†	w'ly	47·01	0·73	Var.	49·21	1·56	E'ly	51·60	0·47†
May 30–June 25 .	w'ly	52·87	0·23	s.w.	58·71	0·87†	S.E.	48·64	0·40	N'ly	69·64	
June 26–July 22 .	w'ly	61·57	1·07†	s.w.	59·67	0·58	s.	60·83	1·03	w'ly	60·07	0·22
July 23–Aug. 19 .	s'ly	58·57	0·64	s.w.	53·43	0·06	N'ly	58·50	0·55	w'ly	52·21	0·69
Aug. 20–Sept. 15 .	Var.	54·83	0·41	s.w.	57·21	0·48	E'ly	58·86	..	N.E.	59·50	0·17
Sept. 16–Oct. 13 .	N'ly	57·71	0·04	Var.	53·21	0·27	N.E.	43·28	..	N.E.	45·14	0·05
Oct. 14–Nov. 9 ..	N'ly	42·92	0·58	N'ly	43·14	0·07	s'ly	42·14	0·64	S.E.	50·21	0·24
Nov. 10–Dec. 6 ..	s.w.	47·50	1·02	N.W.	45·00	..	s.w.	44·14	0·18	Var.	41·14	0·90
Dec. 7–26	Var.	32·67	0·61	S.E.	40·42	2·52	N.E.	29·36	0·10			
Mean.....	..	47·66	6·77	..	47·99	5·84	..	46·11	8·79	..	48·70	4·48

Table IV.—1818.

Dec. 27–Jan. 2 ..	..	....	..	..	....	..	..	....	..	Var.	30·00	0·11
Jan. 3–29	S.E.	37·71	0·92	w'ly	45·00	0·55	Var.	35·07	0·30	w'ly	38·67	0·55
Jan. 30–Feb. 26..	N'ly	31·75	0·25	Var.	29·93	..	S.E.	36·00	0·42	Var.	38·21	1·83
Feb. 27–Mar. 25 .	S.W.	40·50	1·38†	Var.	38·15	0·66	w'ly	34·83	0·48	s.w.	40·83	1·34
Mar. 26–Apr. 21 .	E'ly	39·25	0·56	s.w.	41·64	0·69	s'ly	45·71	0·72	S.E.	44·86	0·16
Apr. 22–May 19..	S.E.	49·71	1·52†	Var.	53·50	1·16	s'ly	53·71	1·96	Var.	52·28	0·16
May 20–June 15 .	E'ly	51·50	..	N.E.	56·57	..	w.	62·36	..	S.E.	66·07	0·03†
June 16–July 12 .	s.w.	62·78	0·40†	s'ly	64·86	0·20†	N'ly	55·78	..	S.E.	65·64	0·34
July 13–Aug. 9..	N.E.	69·78	..	s'ly	69·78	0·11†	N.	64·14	0·12	s'ly	68·36	
Aug. 10–Sept. 5..	N.E.	59·92	..	N.W.	58·71	..	w'ly	63·73	0·10	s.w.	63·07	1·06†
Sept. 6–Oct. 2 ..	N.W.	53·83	0·03†	w'ly	54·07	0·37†	S.E	57·07	1·57	S.E.	58·43	0·45
Oct. 3–30	N.W.	50·71	1·12	s.w.	57·64	0·37	Var.	50·78	..	s.w.	50·78	0·13
Oct. 31–Nov. 26 .	Var.	53·00	0·31	S.E.	47·43	0·98	s'ly	45·50	0·97	S.E.	42·78	0·59
Nov. 27–Dec. 23 .	s.w.	48·83	0·20	s'ly	43·71	0·80	N.E.	34·86	0·02	w'ly	32·36	0·14
Dec. 24–30.....	Var.	31·28										
Mean.....	..	46·47	6·69	..	50·84	5·89	..	49·19	6·66	..	49·45	6·89

Table V.—1819.

	South decl.			Mean decl.			North decl.			Mean decl.		
	Wd.	M. Temp.	Rn.	Wd.	M. Temp.	Rn.	Wd.	M. Temp.	Rn.	Wd.	M. Temp.	Rn.
		degr.	in.		degr.	in.		degr.	in.		degr.	in.
Dec. 31–Jan. 19..	..	....	..	Var.	33·14	..	s.w.	41·33	0·87	w'ly	41·28	0·54
Jan. 20–Feb. 15..	s.e.	39·86	0·35	w'ly	38·00	0·43	Var.	37·43	0·58	w'ly	40·93	0·51
Feb. 16–Mar. 15..	s.e.	43·64	1·20	s.e.	36·14	1·02	n.e.	40·21	0·18	n'ly	42·86	
Mar. 16–Apr. 11 .	n.w.	42·57	0·16	s.w.	48·71	0·59†	n.	53·08	0·08	s.e.	49·43	0·57
Apr. 12–May 8 ..	n.e.	49·43	1·12†	s.w.	48·64	0·86	e'ly	44·17	..	s.e.	56·86	0·68†
May 9–June 5....	n.w.	57·00	0·18	Var.	56·36	1·16	n.e.	52·86	0·31	s.w.	58·57	0·23
June 6–July 2 ..	s'ly	59·83	0·27†	Var.	65·71	0·86	n.w.	60·71	0·05	w'ly	58·36	0·57
July 3–29	w'ly	67·50	0·70	n'ly	62·57	..	Var.	63·07	0·73	n'ly	65·57	
July 30–Aug. 25 .	n'ly	66·43	0·16†	n.w.	65·93	..	n.	68·75	..	n.e.	67·00	
Aug. 26–Sept. 22	n'ly	61·57	0·25	w'ly	63·36	0·37	s.e.	61·71	0·36	n.	52·43	0·09
Sept. 23–Oct. 19 .	Var.	58·21	1·76	s.w.	57·64	0·10	s.e.	62·58	..	n'ly	47·86	
Oct. 20–Nov. 15 .	n.w.	40·07	1·07	n'ly	40·86	0·94	w'ly	43·08	0·13	n'ly	42·43	0·80
Nov. 16–Dec. 13 .	n'ly	37·07	0·70	w'ly	35·21	0·25	Var.	39·71	0·82	Var.	25·57	
Dec. 14–26.....	s.w.	42·64	1·00	w'ly	36·92	0·80						
Mean.....	..	51·22	8·92	..	49·23	7·38	..	51·44	4·11	..	49·93	3·99

Table VI.—1820.

Dec. 27–Jan. 10..	..	....	..	..	....	..	..	26·69	0·05	n.e.	25·07	0·05
Jan. 11–Feb. 6 ..	Var.	22·07	..	Var.	32·00	1·05	s'ly	43·21	0·58	Var.	37·14	0·10
Feb. 7–Mar. 4 ..	w'ly	41·92	0·15	n.e.	32·14	..	Var.	37·50	0·84	n'ly	32·50	0·18
Mar. 5–31	Var.	35·21	..	Var.	44·75	..	n'ly	43·21	0·13	w'ly	47·57	0·08
Apr. 1–28	s.e.	50·43	0·32	Var.	48·21	0·98	n.w.	51·71	..	n.e.	49·28	0·28
Apr. 29–May 25 .	Var.	47·78	..	w'ly	56·67	0·14	n.e.	47·78	1·19	s'ly	57·57	0·71
May 26–June 21 .	w.	54·14	0·81†	n.w.	52·67	0·80	s.w.	55·78	0·74†	n.w.	55·78	0·78
June 22–July 19 .	n'ly	69·57	0·18	s.e.	56·86	0·35	s.e.	58·64	..	n.e.	62·71	2·26†
July 20–Aug. 15 .	n.w.	62·17	0·05†	s.e.	66·71	0·76†	w'ly	65·36	0·75	n.w.	63·93	
Aug. 16–Sept. 11 .	s.w.	59·93	0·66†	s.w.	58·42	0·41	n.e.	55·36	..	Var.	58·78	
Sept. 12–Oct. 8 ..	Var.	58·36	1·74	w'ly	52·86	0·46	w'ly	50·28	0·29	n.e.	50·17	0·05
Oct. 9–Nov. 5 ..	Var.	47·57	0·32	w'ly	46·57	1·07	w'ly	45·57	0·86	Var.	39·86	0·26
Nov. 6–Dec. 2 ..	Var.	45·86	0·26	n'ly	35·50	0·46	s.e.	43·43	0·82	n'ly	38·71	0·05
Dec. 3–29	w'ly	47·73	0·10	e'ly	40·93	1·23	s'ly	42·42	0·31	n.e.	30·86	
Mean.....	..	49·44	4·59	..	48·02	7·71	..	47·63	6·56	..	46·42	4·80

Table VII.—1821.

	South decl.			Mean decl.			North decl.			Mean decl.		
	Wd.	M. Temp.	Rn.	Wd.	M. Temp.	Rn.	Wd.	M. Temp.	Rn.	Wd.	M. Temp.	Rn.
		degr.	in.		degr.	in.		degr.	in.		degr.	in.
Dec. 30–Jan. 26..	E.	27·57	..	N.E.	40·14	1·20	S.E.	42·71	1·64	Var.	37·28	0·05
Jan. 27–Feb. 22..	s'ly	40·00	..	w'ly	35·83	..	N.E.	34·43	..	N.W.	32·14	0·08
Feb. 23–Mar. 21 .	S.E.	32·64	0·26	s.w.	43·50	1·24	s.w.	45·42	0·19	N.W.	40·78	0·39
Mar. 22–Apr. 18 .	s'ly	42·57	0·79	s.w.	44·00	0·71	w'ly	59·28	0·33	w'ly	44·79	0·23†
Apr. 19–May 15..	Var.	54·79	0·52†	N'ly	54·33	0·01	s.w.	55·57	0·13	N.W.	52·07	0·58†
May 16–June 11..	N.E.	47·86	0·79	N.W.	44·93	0·34†	N.E.	56·67	0·06	N'ly	54·07	1·83
June 12–July 8 ..	N.E.	54·07	0·01	N.E.	53·21	0·01	w.	60·50	1·17†	N'ly	54·93	0·37
July 9–Aug. 5 ..	S.E.	58·14	0·57	N.W.	62·21	0·21†	w'ly	61·00	0·63	s'ly	65·50	0·29
Aug. 6–Sept. 1 ..	w'ly	60·43	0·50	w'ly	64·33	0·16	Var.	65·64	0·09	E.	62·64	1·34†
Sept. 2–28	S.E.	66·07	0·11†	N.	59·64	0·80†	w'ly	61·67	1·09†	N.E.	57·78	0·48
Sept. 29–Oct. 26 .	S.	54·43	1·19	Var.	52·14	0·17	S.E.	50·00	0·21	S.W.	48·07	0·76
Oct. 27–Nov. 22 .	Var.	51·71	0·33	w.	41·36	0·49	S.E.	50·83	0·90	w'ly	48·36	2·09
Nov. 23–Dec. 20 .	Var.	46·21	0·90	N.W.	43·28	1·23†	s'ly	45·21	0·05	S.W.	46·14	0·99
Dec. 21–26.....	Var.	41·00	1·50									
Mean.....	..	48·39	7·47	..	49·14	6·57	..	52·99	6·49	..	49·58	9·48

Table VIII.—1822.

Dec. 27–Jan. 15..	..	....	..	Var.	39·78	1·35	s.w.	35·08	0·24	N.W.	40·71	0·02
Jan. 16–Feb. 12 ..	w'ly	39·71	..	w'ly	40·64	0·25	s.w.	42·21	0·40	s'ly	43·71	0·20
Feb. 13–Mar. 11 .	w'ly	44·07	0·09	w'ly	44·17	0·13	s.w.	41·75	0·11	S.W.	45·43	0·96
Mar. 12–Apr. 7 ..	w'ly	47·21	0·12	N.W.	49·28	0·23	s.w.	41·42	0·18	N'ly	45·71	
Apr. 8–May 5 ..	S.E.	44·64	0·46†	S.E.	51·78	1·64†	s.w.	52·64	0·34	N.E.	55·86	0·35†
May 6–June 1 ..	N.E.	53·21	..	N.	57·75	..	S.E.	65·00	0·33†	S.W.	62·86	0·11
June 2–28	S.E.	65·78	..	N.	66·00	0·93†	S.E.	59·67	..	N.E.	67·86	0·21†
June 29–July 26 .	w'ly	61·21	0·86†	w'ly	63·57	0·40	S.E.	64·36	0·73†	S.W.	65·14	0·38
July 27–Aug. 22 .	w'ly	60·86	0·94†	N'ly	72·00	..	w'ly	64·17	0·11†	Var.	67·78	0·02
Aug. 23–Sept. 18.	S.E.	59·86	1·11†	w'ly	59·28	0·17	w'ly	47·28	..	N.E.	56·08	0·05
Sept. 19–Oct. 16 .	S.E.	54·14	1·41	N'ly	52·86	0·35	S.E.	55·86	0·83†	S.W.	50·36	1·08
Oct. 17–Nov. 12..	Var.	49·07	1·02†	S.E.	50·64	0·34	s.w.	51·75	0·10	N.E.	45·93	0·38
Nov. 13–Dec. 9 ..	w'ly	45·14	2·11	s.w.	48·78	0·54	s.w.	39·78	1·01	w'ly	38·75	0·68
Dec. 10–23.....	E'ly	32·99	..	N.E.	34·78							
Mean.....	..	50·60	8·12	..	52·24	6·33	..	50·83	4·38	..	52·78	4·44

Table IX.—1823.

	South decl.			Mean decl.			North decl.			Mean decl.		
	Wd.	M. Temp.	Rn.	Wd.	M. Temp.	Rn.	Wd.	M. Temp.	Rn.	Wd.	M. Temp.	Rn.
		degr.	in.		degr.	in.		degr.	in.		degr.	in.
Dec. 24–Jan. 6 ..	..	....	..	..	....	..	E'ly	26·93	0·76	S.E.	37·21	
Jan. 7–Feb. 2....	N.E.	27·78	..	N.W.	23·57	0·75	N.E.	25·58	1·00	S.E.	40·50	0·68
Feb. 3–Mar. 1 ..	E'ly	35·21	0·97	S.W.	40·86	0·49	N.W.	34·08	0·81	W'ly	38·78	0·53
Mar. 2–28	N.W.	38·36	0·08	S.E.	39·78	0·32	S.W.	41·33	0·69	N'ly	42·57	0·01
Mar. 29–Apr. 24 .	E.	49·71	0·46	N.W.	43·21	0·60	N.E.	45·78	0·02	W'ly	43·92	0·29
Apr. 25–May 22 .	S.E.	46·43	0·51	E'ly	55·43	0·03	S.W.	56·07	0·31	Var.	55·86	0·33
May 23–June 18 .	S.W.	57·07	0·31	E'ly	58·64	0·66†	N.W.	56·21	0·01	N'ly	58·59	
June 19–July 16..	N'ly	55·93	0·08	Var.	60·07	1·38†	W'ly	60·28	0·50†	S.W.	61·71	0·59
July 17–Aug. 12..	Var.	62·64	0·40†	W'ly	58·75	0·67	W'ly	62·21	0·40	W'ly	61·07	0·24
Aug. 13–Sept. 8..	S.E.	60·14	0·20	Var.	62·36	0·97†	W'ly	62·64	0·30	N.E.	56·75	
Sept. 9–Oct. 6 ..	Var.	59·64	0·02†	W'ly	54·57	0·37	N.W.	52·71	0·21	S.E.	49·93	1·38†
Oct. 7–Nov. 2 ..	S.W.	47·36	0·63	E.	48·21	0·03	E'ly	47·71	..	N'ly	41·00	1·93
Nov. 3–29	Var.	46·21	1·11	E.	36·64	..	Var.	44·00	..	S.W.	46·75	0·48
Nov. 30–Dec. 27 .	W'ly	43·14	0·96	W'ly	37·07	..	S.E.	37·28	0·48	N.W.	41·78	0·63
Mean	..	48·43	5·73	..	47·63	6·27	..	46·63	5·49	..	48·31	7·09

Table X.—1824.

Dec. 28–Jan. 23..	S.W.	40·86	0·39	W'ly	37·14	0·23	W'ly	29·25	..	W'ly	39·14	0·52
Jan. 24–Feb. 19..	W'ly	41·64	0·12	S.E.	36·93	0·23	W'ly	43·43	1·16	N.	37·33	0·08
Feb. 20–Mar. 18 .	E.	43·86	0·51	N.W.	36·00	0·40	S.W.	42·93	0·90	N.W.	41·86	0·25
Mar. 19–Apr. 14 .	Var.	42·08	0·64	N'ly	36·71	0·19	N'ly	38·71	0·49	N.E.	40·93	0·26
Apr. 15–May 11 .	E'ly	46·43	1·19	S.E.	54·71	0·19	W'ly	53·28	0·72	S.E.	53·75	0·05
May 12–June 7 ..	N.E.	46·28	2·91	N'ly	47·71	0·11	Var.	58·25	0·01	N.E.	60·36	
June 8–July 5 ..	Var.	55·50	1·64	S.E.	55·93	0·67	Var.	60·50	1·35	S'ly	59·71	0·53
July 6–Aug. 1 ..	W'ly	65·64	0·06	Var.	66·36	0·65†	N'ly	65·17	..	E'ly	59·71	0·55
Aug. 2–29	W'ly	63·71	0·32	W'ly	62·14	1·16	W'ly	61·50	0·43†	N.E.	62·36	
Aug. 30–Sept. 25	S.E.	67·86	0·10	W'ly	60·43	2·57†	Var.	64·50	0·03	N'ly	56·28	0·67
Sept 26–Oct. 22..	S.E.	50·07	0·79†	Var.	55·71	0·67	N'ly	42·64	0·76	Var.	45·25	
Oct. 23–Nov. 18..	Var.	51·50	0·44	W'ly	43·08	0·29	N.W.	46·93	0·97	S.W.	47·00	0·62
Nov. 19–Dec. 15 .	S.E.	45·64	1·49	S.W.	43·00	1·18	Var.	36·07	1·05	W'ly	41·25	0·08
Dec. 16–29	W'ly	43·08	0·35	W'ly	43·28	1·11						
Mean	..	50·29	10·95	..	48·51	9·65	..	49·47	7·87	..	49·61	3·61

Table XI.—1825.

	South decl.			Mean decl.			North decl.			Mean decl.		
	Wd.	M. Temp.	Rn.	Wd.	M. Temp.	Rn.	Wd.	M. Temp.	Rn.	Wd.	M. Temp.	Rn.
		degr.	in.		degr.	in.		degr.	in.		degr.	in.
Dec. 30–Jan. 12 .	..	....	..	..	....	..	w'ly	43·28	0·27	N.	38·64	
Jan. 13–Feb. 8 ..	w'ly	39·25	0·45	N'ly	36·14	0·21	w.	38·57	0·08	N.W.	35·43	0·53
Feb. 9–Mar. 8 ..	w'ly	36·93	..	Var.	42·57	0·25	Var.	37·43	0·13	s'ly	38·86	0·59
Mar. 9–Apr. 4 ..	E.	41·43	0·28	s'ly	35·92	..	N.E.	41·07	..	E.	43·57	
Apr. 5–May 1....	N.E.	48·86	..	N.W	48·43	..	s'ly	50·93	0·90	S.E.	53·00	1·50†
May 2–29	S.	59·43	0·28†	E.	54·43	1·87	N.E.	51·78	..	w'ly	55·00	0·45
May 30–June 25 .	w'ly	53·36	0·29	E.	61·71	..	N.E.	52·71	..	Var.	56·71	0·12
June 26–July 22 .	N.W.	61·14	0·32	N.	63·28	0·04	w'ly	73·71	..	S.E.	71·92	
July 23–Aug. 18 .	N.E.	61·14	..	S.E.	68·93	0·56	S.W.	63·21	1·05†	N.W.	64·17	0·54
Aug. 19–Sept. 15.	N.E.	64·07	..	S.E.	56·71	0·78	N.W.	62·78	..	s'ly	65·78	0·92†
Sept. 16–Oct. 12 .	S.E.	66·50	0·58	w'ly	59·00	0·64	S.E.	57·28	1·09	s'ly	57·50	0·63
Oct. 13–Nov. 9 ..	S.W.	54·36	0·72	N'ly	42·93	..	N.W	43·71	0·30	N.W.	41·36	1·08
Nov. 10–Dec. 6 ..	N'ly	35·25	0·40	S.W.	41·07	0·47	w'ly	42·36	0·96	Var.	38·00	1·35
Dec. 7–26	S.E.	42·17	0·17	w'ly	48·86	0·84	S.E.	47·14	0·24			
Mean.....	..	51·07	3·49	..	50·76	5·66	..	50·42	5·02	..	50·76	7·71

Table XII.—1826.

Dec. 27–Jan. 2 ..	..	....	..	..	....	..	..	....	..	N.W.	35·21	0·10
Jan. 3–30	E.	34·21	0·20	N.W.	23·43	—	w'ly	37·64	—	S.E.	34·57	
Jan. 31–Feb. 26 .	N.	44·92	0·16	Var.	37·28	0·01	s'ly	44·57	0·75	W.	43·21	0·62
Feb. 27–Mar. 26 .	w'ly	45·71	0·66	E'ly	47·36	0·14	N.W.	39·93	0·29	N.E.	38·21	0·37
Mar. 27–Apr. 22 .	w'ly	41·75	..	N.W.	54·14	..	W.	54·21	0·81	S.E.	51·15	
Apr. 23–May 19..	N.W.	50·75	0·31	N'ly	44·00	0·13	N.E.	47·78	0·16	S.E.	54·07	0·14
May 20–June 15 .	N'ly	58·83	0·84	S.E.	56·46	2·10	N'ly	59·57	0·01	N'ly	67·14	
June 16–July 12 .	N'ly	61·75	..	S.E.	68·36	0·52†	Var.	71·28	0·05	S.W.	71·57	0·11
July 13–Aug. 9 ..	w'ly	65·21	0·15	Var.	62·07	2·33	Var.	67·86	0·02†	N'ly	67·93	1·24†
Aug. 10–Sept. 5..	Var.	62·25	0·35	E'ly	67·28	..	w'ly	67·28	0·20†	S.E.	63·50	1·15
Sept. 6–Oct. 3 ..	S.E.	57·79	1·10	Var.	59·50	0·61	E'ly	56·43	0·63	Var.	58·00	0·06
Oct. 4–29	w'ly	41·50	0·43	S.W.	57·00	0·24†	S.E.	58·14	0·73†	w'ly	49·58	0·61
Oct. 30–Nov. 26 .	N'ly	46·64	1·56	w'ly	39·64	0·01	N'ly	41·78	0·72	N'ly	38·50	
Nov. 27–Dec. 23 .	S.W.	41·42	0·64	w'ly	42·36	0·73	S.E.	46·07	0·34	Var.	39·64	0·15
Dec. 24–30.....	N'ly	40·78	0·03									
Mean.....	..	49·49	6·43	..	50·68	6·82	..	53·27	4·71	..	50·88	4·55

Table XIII.—1827.

	South decl.			Mean decl.			North decl.			Mean decl.		
	Wd.	M.Temp.	Rn.	Wd.	M.Temp.	Rn.	Wd.	M.Temp.	Rn.	Wd.	M.Temp.	Rn.
		degr.	in.		degr.	in.		degr.	in.		degr.	in.
Dec. 31–Jan. 20..	..	....	..	N.W.	31·14	0·33	S.W.	43·36	0·48	N.W.	33·36	0·04
Jan. 21–Feb. 16..	Var.	26·00	..	Var.	38·21	0·30	N.E.	32·64	—	N.W.	31·14	—
Feb. 17–Mar. 15..	N'ly	27·36	0·13	S.E.	42·36	1·36	S.W.	42·75	0·44	Var.	44·07	0·77
Mar. 16–Apr. 12 .	N.W.	44·93	0·28	W'ly	44·00	0·34	W'ly	48·28	0·06	S'ly	53·57	0·42
Apr. 13–May 9 ..	N'ly	49·75	0·33	W'ly	41·51	0·13	S.E.	55·57	..	W'ly	55·00	0·67
May 10–June 6 ..	Var.	51·36	0·23	S'ly	61·21	0·55	W'ly	57·43	0·62	S.W.	56·71	0·21
June 7–July 3 ..	N'ly	59·00	0·01	N.E.	64·96	—	S.E.	60·14	0·24	S.W.	64·64	0·62
July 4–31	W'ly	68·00	0·09	S.E.	64·57	..	W'ly	64·81	0·60	W'ly	67·45	0·35†
Aug. 1–27	Var.	66·25	0·35	S.E.	61·21	0·83†	S.W.	62·75	0·69†	N'ly	59·37	0·11
Aug. 28–Sept. 23.	Var.	57·58	0·01	N.E.	59·50	0·84	S.W.	61·00	0·42	Var.	57·50	1·01
Sept. 24–Oct. 20 .	S'ly	58·58	0·99	S.E.	56·21	0·08	N.W.	52·69	1·81†	S.W.	55·75	0·86
Oct. 21–Nov. 17..	S.E.	55·07	1·03	N'ly	45·79	0·74	Var.	48·43	0·09	N.W.	45·71	0·47
Nov. 18–Dec. 14..	Var.	37·17	—	Var.	38·43	0·73	W'ly	46·36	0·33	Var.	43·64	1·44
Dec. 15–27	S.W.	47·33	1·05	S.W.	44·29	0·61						
Mean	..	49·87	4·50	..	49·53	6·84	..	52·02	5·78	..	51·38	6·97

Table XIV.—1828.

Dec. 28–Jan. 11..	..	....	..	..	....	..	S.E.	37·79	0·93	S.E.	32·81	
Jan. 12–Feb. 7 ..	Var.	40·00	2·40	S.W.	48·57	0·07	S'ly	42·14	0·20	W'ly	46·71	0·16
Feb. 8–Mar. 5 ..	N'ly	35·25	0·40	Var.	36·50	0·10	Var.	44·78	0·25	N.W.	44·21	0·02
Mar. 6–Apr. 2 ..	W'ly	48·21	0·15	W'ly	52·66	—	N.W.	40·85	0·26	Var.	39·12	0·55
Apr. 3–29	S.E.	41·91	0·39	W'ly	51·85	0·34	N'ly	50·33	1·49	W'ly	50·81	0·44
Apr. 30–May 26 .	E'ly	55·50	..	N'ly	53·00	0·19	S.E.	57·79	..	E'ly	60·14	0·87
May 27–June 23 .	N.W.	62·21	0·50	W'ly	56·33	1·12	Var.	62·64	—	N.E.	64·31	2·19†
June 24–July 20 .	Var.	68·00	..	S.E.	71·58	0·80	Var.	65·00	2·33	W'ly	65·21	1·41
July 21–Aug. 16 .	W'ly	63·58	1·57	N.W.	62·30	0·22	S.W.	63·07	0·99	N.W.	60·43	1·59
Aug. 17–Sept. 13.	W'ly	60·93	0·24	Var.	65·50	....	N.E.	62·14	—	S.E.	64·50	1·16†
Sept. 14–Oct. 10 .	E'ly	54·83	0·03	S.E.	58·71	0·21	S.W.	54·41	1·17	N.W.	55·00	0·51
Oct. 11–Nov. 6 ..	N.W.	54·08	..	Var.	49·00	0·36	E'ly	44·50	0·08	N.W.	46·35	
Nov. 7–Dec. 4 ..	Var.	35·30	—	S.E.	47·41	0·75	S'ly	45·50	0·27	W'ly	47·37	
Dec. 5–24	Var.	44·16	0·94	Var.	48·85	0·47	W'ly	49·80	0·09			
Mean	..	51·07	6·62	..	54·02	4·63	..	51·48	8·06	..	52·07	8·90

Table XV.—1829.

	South decl.			Mean decl.			North decl.			Mean decl.		
	Wd.	M. Temp.	Rn.	Wd.	M. Temp.	Rn.	Wd.	M. Temp.	Rn.	Wd.	M. Temp.	Rn.
		degr.	in.		degr.	in.		degr.	in.		degr.	in.
Dec. 25–31.....	..	....	..	..	....	..	..	....	..	Var.	39·50	0·16
Jan. 1–28	N.W.	35·08	0·31†	N'ly	35·00	—	N.E.	31·36	—	Var.	29·56	0·20
Jan. 29–Feb. 24..	Var.	32·58	..	w'ly	39·83	—	w'ly	43·57	—	Var.	40·75	0·37
Feb. 25–Mar. 23 .	E'ly	34·67	0·50	N.W.	37·94	—	E.	34·17	..	E'ly	45·19	0·09
Mar. 24–Apr. 19 .	N.E.	45·00	0·40	w'ly	41·42	0·20	Var.	47·50	1·74	s'ly	49·14	1·14†
Apr. 20–May 17..	E'ly	47·14	0·83	w'ly	46·57	0·15	w'ly	52·75	0·14	Var.	55·44	0·08
May 18–June 13..	Var.	60·50	..	N.E.	55·86	0·20	N.W.	55·00	0·04	s.w.	56·21	—
June 14–July 11 .	w'ly	62·71	0·29†	S.E.	62·92	0·81	N.W.	62·17	1·38	w'ly	60·19	1·35
July 12–Aug. 7 ..	Var.	65·92	0·89	N.W.	63·64	1·06†	Var.	59·58	0·32	Var.	61·12	0·95
Aug. 8–Sept. 3 ..	Var.	64·50	0·63	S.E.	57·07	1·92†	N.W.	58·42	0·75	N'ly	57·75	0·87
Sept. 4–30	s.w.	56·57	0·96	w'ly	53·50	1·30†	w'ly	55·50	1·00	w'ly	50·36	0·09
Oct. 1–27	E.	52·27	1·52	N.W.	46·77	0·08	w'ly	51·50	0·18	N.W.	44·58	..
Oct. 28–Nov. 24 .	w'ly	42·56	0·36	w'ly	42·67	0·50	Var.	45·00	0·26	N'ly	32·27	0·48
Nov. 25–Dec. 22 .	E'ly	38·43	0·02	S.E.	38·25	..	Var.	34·43	..	N.E.	32·12	0·10
Mean	..	49·05	6·71	..	47·80	6·22	..	48·53	5·81	..	46·73	5·88

Table XVI.—1830.

Dec. 23–Jan. 18..	N.E.	26·50	0·24	N.E.	31·43	..	N.W.	33·64	0·42	N'ly	25·64	..
Jan. 19–Feb. 14..	Var.	33·50	..	S.E.	31·29	1·00	N.E.	24·14	—	w'ly	37·21	0·70
Feb. 15–Mar. 14 .	N.W.	34·50	—	W.	46·36	0·95	E'ly	41·83	..	E'ly	44·81	0·16
Mar. 15–Apr. 10 .	N.W.	47·58	0·22	w'ly	47·64	0·20	S.E.	46·08	1·30	w'ly	44·56	0·46
Apr. 11–May 7 ..	w'ly	51·71	0·63†	W.	52·33	0·61†	S.E.	54·64	..	s.w.	57·21	
May 8–June 3 ..	S.E.	52·00	0·66	N.W.	58·43	0·15	S.E.	59·25	0·78†	w'ly	57·43	1·30
June 4–July 1 ..	w'ly	56·50	0·75	E'ly	54·17	1·20†	N'ly	56·17	0·30	S.E.	63·44	0·77
July 2–28	w'ly	61·21	0·50†	s'ly	60·07	0·09	w'ly	61·92	0·72	E'ly	69·43	
July 29–Aug. 25 .	Var.	69·07	0·50	S.E.	62·79	0·12	w'ly	56·67	2·22†	N.W.	56·69	0·17
Aug. 26–Sept. 21.	w'ly	57·58	0·82	w'ly	56·93	0·37†	w'ly	53·79	0·80	s'ly	54·93	1·38
Sept. 22–Oct. 18 .	w'ly	53·86	0·67	w'ly	53·50	0·07	N'ly	53·64	..	E'ly	46·71	
Oct. 19–Nov. 15 .	s'ly	54·43	0·65	N.W.	47·00	0·28	w'ly	50·50	1·07	s'ly	44·37	1·16
Nov. 16–Dec. 11 .	w'ly	42·17	0·74	S.E.	37·36	0·24	S.E.	39·50	0·05	N.E.	41·79	0·48
Dec. 12–25.... .	w'ly	34·12	0·41	N.W.	31·00							
Mean	..	48·20	6·79	..	47·88	5·28	..	48·59	7·66	..	49·55	6·58

Table XVII.—1831.

	South decl.			Mean decl.			North decl.			Mean decl.		
	Wd.	M. temp.	Rn.	Wd.	M. temp.	Rn.	Wd.	M. temp.	Rn.	Wd.	M. temp.	Rn.
		degr.	in.		degr.	in.		degr.	in.		degr.	in.
Dec. 26–Jan. 8 ..	..	....	..	..	....	..	s'ly	32·93	0·45	S.E.	32·35	..
Jan. 9–Feb. 4 ..	N.E.	34·28	—	S.E.	41·65	0·93	N'ly	32·41	0·43	E'ly	30·93	1·15
Feb. 5–Mar. 4 ..	s'ly	46·85	0·42	w'ly	43·93	0·22	N.W.	38·21	0·30	w'ly	43·93	0·22
Mar. 5–31	w'ly	44·21	0·38	w'ly	46·65	0·68	N'ly	42·17	..	S.E.	45·07	0·58
Apr. 1–27	w'ly	45·93	0·39	E'ly	53·15	1·33†	N'ly	48·25	..	S.E.	53·85	..
Apr. 28–May 25 .	S.E.	50·44	0·81†	N.W.	44·00	..	E'ly	52·95	..	w'ly	62·21	0·9†
May 26–June 21 .	E'ly	57·95	0·70	N.W.	58·45	0·22†	w'ly	63·75	0·39	S.W.	64·21	0·08
June 22–July 18 .	N'ly	59·57	0·66	w'ly	63·30	0·08	Var.	66·35	0·12†	s'ly	64·55	1·73†
July 19–Aug. 15 .	S.W.	61·25	0·31	N.E.	68·57	1·39†	Var.	68·50	1·16†	N'ly	64·65	0·30
Aug. 16–Sept. 11 .	N.W.	62·30	1·58†	w'ly	63·65	..	N.W.	58·66	1·68	w'ly	59·30	0·83
Sept. 12–Oct. 9 ..	w'ly	57·21	..	s'ly	58·21	0·30	S.E.	62·91	2·10†	w'ly	58·37	1·25†
Oct. 10–Nov. 4 ..	s'ly	57·57	0·96	s'ly	56·50	0·12	S.W.	53·50	1·02	Var.	45·57	0·18
Nov. 5–Dec. 2 ..	s'ly	45·81	0·22	N.W.	36·07	0·45	w'ly	49·16	0·65	N'ly	39·36	0·16
Dec. 3–22	S.W.	48·36	1·37	s'ly	46·93	0·80†	S.W.	40·66	0·37			
Mean	..	51·67	7·80	.	52·39	6·52	..	50·74	8·67	..	51·10	6·57

Table XVIII.—1832.

Dec. 23–29 (1831)	..	....	..	..	.. -	..	..	....	..	Var.	32·86	
Dec. 30–Jan. 26. .	E'ly	30·38	..	S.E.	41·65	1·02	N.W.	30·85	..	s'ly	30·84	0·15
Jan. 27–Feb. 22. .	w'ly	38·78	..	Var.	42·78	0·40	E'ly	36·16	..	N'ly	37·07	
Feb. 23–Mar. 20 .	N'ly	36·50	..	s'ly	40·43	0·45	Var.	38·00	0·10	w'ly	43·93	0·43
Mar. 21–Apr. 17 .	N.W.	43·44	0·18	N'ly	46·35	..	E'ly	48·25	..	Var.	49·43	0·24
Apr. 18–May 14 .	s'ly	50·78	0·26	E'ly	48·71	0·70	S.W.	53·25	0·48†	N'ly	46·85	0·20†
May 15–June 10 .	Var.	50·30	0·58	N'ly	56·85	..	S.E.	55·16	0·48	s'ly	57·65	1·86†
June 11–July 8 ..	Var.	62·13	0·96	Var.	60·65	0·68	N.W.	62·91	..	Var.	63·35	0·08
July 9–Aug. 4 ..	w'ly	65·07	0·71†	N.W.	57·57	..	N.	59·58	..	S.E.	62·07	1·08†
Aug. 5–31	w'ly	63·15	0·16	Var.	63·71	..	S.W.	61·07	1·05†	S.E.	57·25	1·25
Sept. 1–27.....	Var.	55·86	0·08	w'ly	55·50	0·10	N.W.	53·00	..	Var.	55·42	
Sept. 28–Oct. 25 .	Var.	57·05	1·95	w'ly	55·64	0·97	w'ly	50·00	0·05	Var.	45·21	0·05
Oct. 26–Nov. 21 .	Var.	45·71	0·56	N'ly	42·93	0·14	S.E.	40·75	0·64	E'ly	42·57	0·05
Nov. 22–Dec. 19 .	Var.	43·93	0·76	w'ly	45·15	0·32†	w'ly	42·78	0·10	S.W.	39·71	0·73
Mean	..	49·47	6·20	..	49·84	4·78	..	48·60	2·90	..	47·44	6·12

[The Synopsis of the Winds, Temperature, and Rain, computed according to the Moon's Declination, referred to in the text of this paper, will be found in the General Table opposite, p. 61ª.]

Synopsis of the Winds, Temperature and Rain, computed according to the Moon's Declination.

Year.	South declination.					Mean decl.				North decl.				Mean decl.				Var.	Yearly mean temperature.		Week's Temperature and Rain.								Year's rain.
																					South decl.		Mean decl.		North decl.		Mean decl.		
	Days.	N.–E.	E.–S.	S.–W.	W.–N.	N.–E.	E.–S.	S.–W.	W.–N.	N.–E.	E.–S.	S.–W.	W.–N.	N.–E.	E.–S.	S.–W.	W.–N.				Temp.	Rain.	Temp.	Rain.	Temp.	Rain.	Temp.	Rain.	
																				degr.	degr.	in.	degr.	in.	degr.	in.	degr.	in.	in.
1815	370	19	19	21	30	20	8	28	28	19	5	35	29	20	10	29	24	26	1815	49·43	51·04	5·74	50·84	5·17	47·94	5·94	48·12	5·37	22·22
1816	368	20	18	31	22	18	21	33	22	15	18	25	24	12	10	21	33	25	1816	46·35	45·00	6·54	47·39	8·93	46·53	10·54	46·42	5·58	31·59
1817	362	17	12	20	24	14	8	46	19	21	15	26	24	24	14	20	29	29	1817	47·56	47·66	6·77	47·99	5·84	46·11	8·79	48·70	4·48	25·88
1818	369	22	17	25	16	19	16	28	20	18	19	23	23	8	28	32	22	33	1818	48·96	46·47	6·69	50·84	5·89	49·19	6·66	49·45	6·89	26·13
1819	361	12	12	21	39	13	16	30	35	20	17	21	26	31	12	19	27	10	1819	50·43	51·22	8·92	49·23	7·38	51·44	4·11	49·93	3·99	24·40
1820	369	17	13	20	35	17	12	23	30	21	14	31	27	30	19	17	25	18	1820	47·85	49·44	4·59	48·02	7·71	47·63	6·56	46·42	4·80	23·66
1821	362	10	20	30	34	17	12	19	36	18	15	22	27	14	11	30	33	14	1821	49·98	48·39	7·47	49·14	6·57	52·99	6·49	49·58	9·48	30·01
1822	362	23	18	22	26	27	15	18	34	15	9	42	18	14	13	29	31	8	1822	51·63	50·60	8·12	52·24	6·33	50·84	4·38	52·78	4·44	23·27
1823	369	20	17	24	28	14	14	27	32	20	15	18	40	16	16	31	28	9	1823	47·74	48·43	5·73	47·63	6·27	46·63	5·49	48·31	7·09	24·58
1824	368	20	20	25	31	19	10	32	32	20	7	24	35	27	10	14	34	8	1824	49·47	50·29	10·95	48·51	9·65	49·47	7·87	49·61	3·61	32·08
1825	362	18	15	27	28	18	14	24	34	21	17	21	36	12	18	23	35	1	1825	50·75	51·07	3·49	50·76	5·66	50·42	5·02	50·76	7·71	21·88
1826	369	18	14	24	33	19	22	17	33	17	25	20	29	20	18	19	37	4	1826	51·35	49·49	6·43	50·68	6·82	53·27	4·71	50·88	4·55	22·51
1827	362	15	20	17	29	19	15	29	33	12	12	31	33	9	15	26	40	7	1827	50·68	49·87	4·50	49·53	6·84	52·02	5·78	51·38	6·97	24·09
1828	363	12	17	17	36	7	15	28	35	9	22	29	36	10	24	22	42	2	1828	52·15	51·07	6·62	54·02	4·63	51·48	8·06	52·07	8·90	28·21
1829	363	12	31	16	28	16	15	13	41	14	10	23	41	19	25	18	37	4	1829	48·00	49·05	6·71	47·80	6·22	48·53	5·81	46·73	5·88	24·62
1830	368	10	9	29	46	13	13	19	49	13	22	16	32	10	26	27	33	1	1830	48·52	48·20	6·79	47·88	5·28	48·59	7·76	49·55	6·58	26·41
1831	362	20	15	25	32	14	17	20	37	13	18	16	41	21	19	19	32	3	1831	51·46	51·67	7·80	52·39	6·52	50·74	8·67	51·10	6·57	29·56
1832	363	15	23	26	29	14	14	21	41	12	15	23	30	18	27	21	2 8	6	1832	48·84	49·47	6·20	49·84	4·78	48·60	2·90	47·44	6·12	20·00
Total...	6572	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	208	Mean ..	49·51	49·36	6·67	49·71	6·47	49·58	6·42	49·40	6·05	25·61
Mean of days...	16·66	17·22	23·50	30·33	16·55	14·05	25·28	32·83	16·55	15·30	24·80	30·61	17·50	17·50	23·17	31·66													

Note.—In the Table of the Winds, the number of days set down "variable" (the wind having blown with some force from opposite quarters in the day) will be found much the most considerable *in the first seven years* of the cycle. It is not doubted that, with the same attention to this particular, as many might have been noted variable in the succeeding years. A few, in which no note of the wind was made, or in which no wind was perceptible, are also included in this division. The mean and total results, both of the days allotted to different Winds, and of the Temperature and Rain, it is presumed will need no explanation, especially when the reader has examined them with the Tables at large; but it may be proper to state here, that the head N.–E. comprehends the points from North, Eastward, *not including East*, and so of the rest. These numbers were computed with care from the Tables of Observations; chiefly those which I have long since published in the 'Climate of London' and elsewhere.

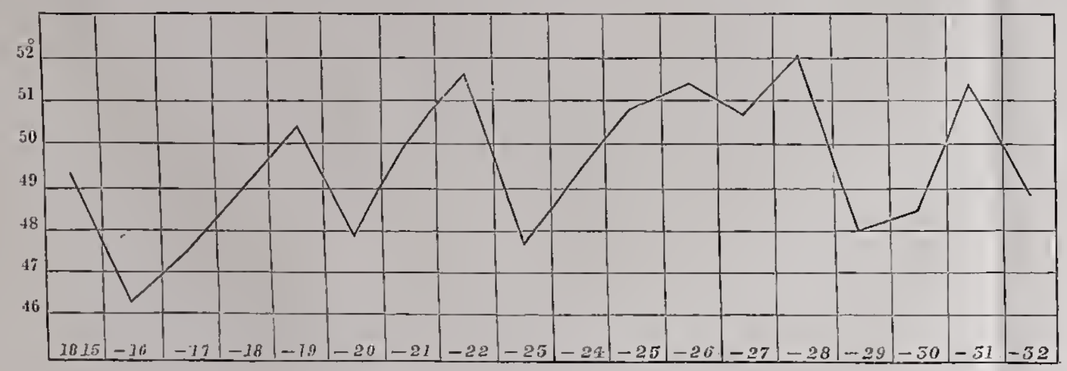


Diagram of the Yearly Mean Temperature.

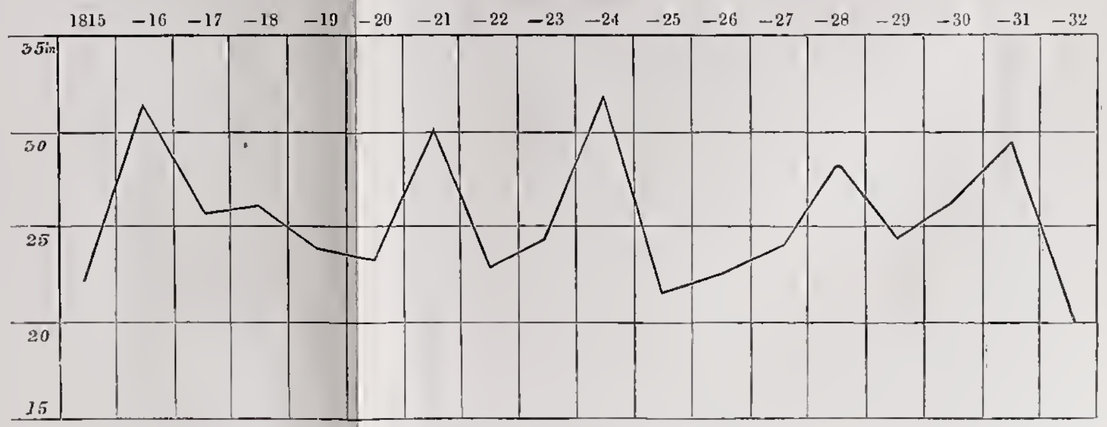


Diagram of the Yearly Rain.

ON THE BAROMETRICAL VARIATION AS AFFECTED BY THE MOON'S DECLINATION*.

These calculations were begun with the year 1815, and continued to 1832: the present paper continues them to 1841. The method used to bring out the averages may be thus described. Beginning as nearly as may be at the winter solstice, the days of a solar year are classed in what may be termed *weeks of declination*, mostly of seven days each, the middle day of each week corresponding,—1, with the moon's position coming north from the equator; 2, with her position in full north declination; 3, with her position returning to south over the equator; 4, with her full south declination. The average, or mean height of the barometer, in each of these classes is presumed to express the relative power, or effect, of the position to which it belongs; when divested of the much larger amount of variation due to the effect of a northerly or southerly current, of the variable pressure of the aqueous atmosphere, of the temperature of the season, the deposition of rain, &c. Mixed with *these*, the weekly averages offer a mass of results sufficiently discordant; but the discrepancy vanishes when those under each class are *averaged upon the solar year*; the other movements now balancing and neutralising each other.

The present series of averages extends then from December 20, 1832, where the former ends, to December 23, 1841. It corresponds nearly with the latter or *cold* half of the cycle of annual temperatures, which I have already laid before the public†. And it being probable that a close connexion exists between the pressure and the temperature of the atmosphere of these latitudes, in its variations, my taking these limits may facilitate to students a careful comparison of the two, throughout a cycle.

In my paper of March 1841‡, the mean height of the barometer for each of the four positions came out, by averages upon eighteen years ending with 1832, as follows, viz.—

Moon coming north over equator	29·8724 in.
Moon in north declination	29·8608 in.
Moon going over equator, south	29·8450 in.
Moon in south declination	29·8261 in.

* Reprinted from the Philosophical Transactions for 1846, p. 441; having been received January 16, and read June 19, in the preceding year..

[† In the author's work, entitled "A Cycle of Eighteen Years in the Seasons of Britain," &c.]

[‡ See p. 39ª of the present collection.]

Hence it was inferred that the barometrical mean is *depressed* in these latitudes by the moon's position in south declination : and that which appeared upon the aggregate of years, was found to hold also in the several nine-years' averages of which it consisted. The depression was stated to be gradual, proceeding through the three changes to the south place ; but upon the planet's quitting her south position to return north, a sudden elevation of the mean, effected in a single week of declination, indicated the return of the pressure (as far as regarded *this* influence) to its former limit.

The results of the present examination differ somewhat in the proportions of pressure shown ; the chief cause being, as I apprehend, the different latitude in which a part of the observations took place. In 1828, near the middle of the year, having given up my house on Tottenham-green, I removed the barometer-clock to the Villa, Ackworth, Yorkshire, in latitude 53° 39′ north, and still on the east side of the island. Here I obtained for some time the yearly circle of the variation : but coming subsequently to spend the winter in the south, from my absence joined with other causes, the clock for several months in the year stood still. I had presented a good barometer to the Friends' Institution at Ackworth, where a good meteorological register is kept at my instance ; and from *this* the maxima and minima, wanting in the series by the clock, have been taken.

Thus circumstanced, and the instrument standing, from the above date, on considerably higher ground, and 2° more to the north, the averages from 1824 to 1832 come out as follows, viz. moon coming north 29·8505 in. ; in north declination 29·8257 in. ; going south 29·8076 in. ; in south declination 29·8058 in. Here we have still the depression to the place of south declination ; but with a check, amounting almost to the doing of it away, in the concluding position. Let us, however, see further.

On the solar years, from 1833 to 1841, *observed wholly at Ackworth*, the averages are,—

Moon coming north	29·7127 in.
Moon in north declination . . .	29·6946 in.
Moon going south	29·6969 in.
Moon in south declination . . .	29·7115 in.

The former variation, presenting a gradual decline of gravity to the moon's south place, is here replaced by one altogether different ; the loss of gravity by the north declination continues into the following week, and is restored (very nearly) in the

fourth week; the moon yet full *south*. Had this discrepancy resulted from less perfect observation merely, it ought to have affected each position alike, and to have made the calculations useless; but we have here even more of *symmetry* than before. There must be something then in the more northern latitude, affecting partially the *mixed* average 1824 to 1832, and more completely the *northern* average 1833 to 1841; which is commended, with all deference, to the study and consideration of our mathematical and astronomical Fellows.

In my former paper, I exhibited likewise a set of averages *upon the whole solar year*, from 1815 to 1832, in which the *yearly mean pressure* increases to the middle of a cycle of eighteen years, and then decreases with great regularity to its former amount. I have inserted here a similar calculation, but with an opposite result; which shows the pressure decreasing from year to year, and then recovering in some measure its former level: but this, for reasons already given, comes out less regular and symmetrical than the other. I have no doubt that, when we shall have prosecuted further the comparison of the yearly mean pressures with the temperatures, there will be found a contrast between the two halves of a cycle as evident as that I have shown to exist in those of the cycle of temperature.

In the long average, 1815 to 1841, we have,—1, a half cycle *cold*; 2, a half cycle *warm*; 3, a half cycle *cold*; the result of which must needs show a preponderance of the effect of cold. But let the temperatures balance, as in the cycle 1815–32, we have then—1, coming north 29·8310 in.; 2, north 29·8260 in.; 3, going south 29·8171 in.; 4, south 29·8056 in. Again, in the balanced cycle 1824–41, we have for the four respectively,—1, coming north 29·7816 in.; 2, north 29·7601 in.; 3, going south 29·7522 in.; 4, south 29·7586 in. The results of this last average are subject in some degree to the effect of a more northerly site. Without presuming to determine even that latitude has such an effect in a space of less than three degrees, I have thought it right to place these data in the hands of the Fellows, that future students may have the opportunity (now that we have begun to distinguish between the various causes affecting the gravity of the atmosphere) of comparing (with much trouble saved) the actual differences which obtain in it, under different positions of the planet, and of analysing, with the help of the register whence they are derived, a great mass of observations tending to throw light on the nascent science of meteorology.

I have to acknowledge, in concluding this paper, my obligations to my young friend Cornelius Hanbury, who made for me the preliminary calculations upon the register with much care, and, I am satisfied, with the required accuracy.

L. H.

Ackworth, October 25, 1844.

Barometrical Averages, &c.

Year.	Days.	Coming North.	North.	Going South.	South.	On the year.
		in.	in.	in.	in.	in.
1833.	369	29·5807	29·6497	29·5333	29·5812	29·5862
1834.	362	29·7733	29·6997	29·6653	29·6001	29·6846
1835.	368	29·8053	29·8507	29·8631	29·8659	29·8462
1836.	362	29·7749	29·4987	29·6004	29·6010	29·6187
1837.	369	29·7098	29·7588	29·6514	29·6595	29·6949
1838.	362	29·5696	29·7061	29·7283	29·6866	29·6702
1839.	368	29·7672	29·7347	29·7626	29·8158	29·7703
1840.	362	29·7851	29·7474	29·7724	29·8699	29·7932
1841.	369	29·6488	29·6055	29·6957	29·7139	29·6659
On nine solar years, 1833–1841.		29·7127	29·6946	29·6969	29·7115	29·7034

Years.	Coming North.	North.	Going South.	South.	On nine years.
	in.	in.	in.	in.	in.
1825–1833.	29·8063	29·7965	29·7812	29·7874	29·7928
1826–1834.	22·7719	29·7599	29·7448	29·7440	29·7552
1827–1835.	29·7403	29·7410	29·7306	29·7301	29·7355
1828–1836.	29·7223	29·6969	29·6896	29·6877	29·6991
1829–1837.	29·7057	29·6943	29·6732	29·6653	29·6846
1830–1838.	29·6930	29·6998	29·6779	29·6638	29·6836
1831–1839.	29·6960	29·7103	29·6782	29·6778	29·6906
1832–1840.	29·7126	29·7177	29·7007	29·7081	29·7098
1833–1841.	29·7127	29·6946	29·6969	29·7115	29·7039
On twenty-seven solar years, 1825–1841.	29·7290	29·7234	29·7081	29·7084	29·7172

Years.		Coming North.	North.	Going South.	South.	
		in.	in.	in.	in.	in.
1815–1823.	On nine years, the barom. at Tottenham . .	29·8115	29·8263	29·8267	29·8054	
1824–1832.	On nine years, the barom. moved 1828.	29·8505	29·8257	29·8076	29·8058	
1833–1841.	On nine years, the barom. at Ackworth . . .	29·7127	29·6946	29·6969	29·7115	
	Mean of the three	29·7916	29·7822	29·7771	29·7742	
				Mean of the whole		29·7812

Barometrical Averages, &c.

Year and Periods.	Days.	Coming N.	Days.	North.	Days.	Going S.	Days.	South.
		in.		in.		in.		in.
December 20–26, 1832	....	....	....	....	....	....	7	29·5243
Dec. 27 to Jan. 22, 1833 ..	7	29·7886	6	30·2941	7	29·9000	7	30·1257
January 23 to February 18..	7	29·7621	7	29·1871	6	29·2008	7	29·0021
February 19 to March 18 ..	7	29·4257	7	29·1750	7	29·9757	7	29·4300
March 19 to April 14	7	29·7528	6	29·5566	7	29·3500	7	29·3143
April 15 to May 12	7	29·5621	7	29·7578	6	29·4266	8	29·8443
May 13 to June 8	6	29·7583	7	29·9700	6	29·9425	8	29·5206
June 9 to July 5	7	29·4278	6	29·5908	7	29·4371	7	29·6064
July 6 to August 1.....	7	29·6471	7	29·7207	6	29·5450	7	30·0657
August 2–29	7	29·8978	7	29·5928	6	29·4733	8	29·6631
August 30 to September 25 .	7	29·5185	6	29·7358	7	29·5121	7	29·5678
September 26 to October 22	7	29·7193	7	29·8985	6	29·3600	7	29·1928
October 23 to November 18	7	29·4064	6	29·5935	7	29·5966	7	29·8314
November 19 to December 16	7	29·4021	7	29·3735	7	29·2128	7	29·4478
December 17–23	7	29·0607						
369 days.	97	29·5807	86	29·6497	85	29·5333	101	29·5812
Dec. 24, 1833 to Jan. 12, 1834	....	....	7	29·3893	6	29·6225	7	29·0400
January 13 to February 8 ..	7	29·2743	7	29·4314	7	29·6665	6	29·7358
February 9 to March 7	8	29·9112	6	29·7541	7	29·9107	6	29·6891
March 8 to April 4	8	30·1481	7	30·1021	6	29·5241	7	29·8421
April 5 to May 1	7	30·0693	7	30·0500	7	30·0064	6	29·3016
May 2–28	8	29·7243	6	29·5083	7	29·6950	6	30·0875
May 29 to June 25	8	29·7450	6	29·4983	7	29·4121	7	29·7314
June 26 to July 22	7	29·9200	7	29·7371	7	29·6593	6	29·4933
July 23 to August 19	8	29·6331	6	29·5483	7	29·6150	7	29·7386
August 20 to September 15..	7	29·4207	6	29·4258	7	29·5286	7	29·7578
September 16 to October 12	7	29·8907	7	29·7886	6	29·8091	7	29·6936
October 13 to November 8..	7	29·3236	7	29·6564	7	29·8757	6	29·2058
November 9 to December 6..	7	29·9678	8	29·7675	6	29·3233	7	29·4850
December 7–20	7	30·0243	7	30·1393				
362 days.	96	29·7733	94	29·6997	87	29·6653	85	29·6001

Barometrical Averages, &c.

Year and Periods.	Days.	Coming N.	Days.	North.	Days.	Going S.	Days.	South.
		in.		in.		in.		in.
Dec. 21, 1834 to Jan. 2, 1835	....	....	....	....	7	30·0643	6	29·8567
January 3–29.....	7	29·9671	7	29·4850	7	29·7264	6	30·1666
January 30 to February 25..	7	30·0557	8	29·9831	6	29·3791	6	29·1775
February 26 to March 25 ..	8	29·5162	7	29·4271	7	29·9464	6	30·3758
March 26 to April 21	7	29·9807	7	30·1186	7	30·1214	6	30·2541
April 22 to May 19	8	29·9812	7	29·7278	6	29·7283	7	29·7500
May 20 to June 15	6	29·9008	8	29·9106	6	29·9558	7	30·2786
June 16 to July 12	7	29·9078	7	29·7628	7	29·9678	6	29·7733
July 13 to August 8	7	29·8571	8	30·1987	6	30·0375	6	29·9716
August 9 to September 5 ..	8	30·0769	7	29·8207	6	29·7808	7	30·0129
September 6 to October 2..	7	29·4550	7	29·5750	7	29·5700	6	29·1733
October 3–29	7	29·5417	7	29·8793	7	29·7829	6	29·5425
October 30 to November 26	7	30·0121	8	30·1881	6	29·8450	7	29·5571
November 27 to Dec. 23 ..	7	29·2164	7	29·9821	7	30·1786	6	30·2325
368 days.	93	29·8053	95	29·8507	92	29·8631	88	29·8659
Dec. 24, 1835 to Jan. 19, 1836	7	30·1350	7	30·1007	7	29·4714	6	29·9450
January 20 to February 16 .	7	29·6457	7	29·0393	7	29·7700	7	30·0293
February 17 to March 14..	6	30·0133	7	29·0414	8	29·2000	6	28·9300
March 15 to April 10	7	29·7564	7	29·0671	7	29·6335	6	29·3508
April 11 to May 8.....	7	29·7843	8	29·7244	6	29·7300	7	29·9786
May 9 to June 4	6	30·1391	8	30·0775	7	30·1714	6	29·5825
June 5 to July 1	6	29·5066	8	29·6937	7	29·6243	6	29·7741
July 2–28	7	29·9357	7	29·5807	7	29·4935	6	29·6441
July 29 to August 25	7	29·7300	8	30·0175	7	29·7607	6	29·6450
August 26 to September 21	6	29·7225	8	29·3287	7	29·8807	6	29·8816
September 22 to October 18	7	29·6143	7	29·1050	7	29·0200	6	29·7158
October 19 to November 15	7	30·0757	8	29·6481	6	29·6116	7	29·3857
November 16 to Dec. 12 ..	6	29·3076	8	29·0594	7	29·4378	6	28·9508
December 13–19	7	29·4828						
362 days.	93	29·7749	98	29·4987	90	29·6004	81	29·6010

Barometrical Averages, &c.

Year and Periods.	Days.	Coming N.	Days.	North.	Days.	Going S.	Days.	South.
		in.		in.		in.		in.
Dec. 20, 1836 to Jan. 8, 1837	.....	.....	7	29·8028	7	30·0964	6	29·8558
January 9 to February 5 ..	7	29·7293	8	29·8131	7	29·6328	6	30·0025
February 6 to March 4	7	29·4414	7	29·3878	7	29·4893	6	29·9933
March 5–31	7	29·6178	7	29·9378	7	29·5564	6	29·5491
April 1–28	7	29·5535	7	29·7250	7	29·4550	7	29·3750
April 29 to May 25	7	29·4535	7	29·5757	7	29·8385	6	29·5741
May 26 to June 21	7	29·6471	7	29·7700	7	29·4428	6	29·5775
June 22 to July 19	7	29·9214	7	29·8828	7	29·8285	7	29·4764
July 20 to August 15	7	29·6957	6	29·2683	8	29·9118	6	30·0016
August 16 to September 11	7	29·6578	7	29·8621	7	29·5843	6	29·6491
September 12 to October 9 .	7	29·5714	7	30·1271	7	30·0593	7	30·0228
October 10 to November 5 .	7	30·1714	6	29·9350	7	29·1971	7	29·0793
November 6 to December 2	7	29·7257	7	29·5578	7	29·3657	6	29·4166
December 3–23	7	30·0418	6	29·9775	8	29·6618		
369 days.	91	29·7098	96	29·7588	100	29·6514	82	29·6595
December 24–30, 1837	....	....	....	....	....	....	7	29·7128
Dec. 31 to Jan. 26, 1838 ..	6	29·8166	7	30·2093	8	29·9450	6	29·6275
January 27 to February 22..	7	29·7735	7	29·6257	7	29·5421	6	29·7900
February 23 to March 22 ..	7	29·0107	6	29·4400	8	29·9170	7	29·3164
March 23 to April 18	6	29·9400	7	30·0471	7	29·6014	7	29·7335
April 19 to May 15	7	29·5357	6	29·6825	8	30·0125	6	29·5541
May 16 to June 11	7	29·3178	6	29·5433	8	29·4331	6	29·5325
June 12 to July 9	7	29·4364	7	29·4621	7	29·5914	7	29·6164
July 10 to August 5	7	29·4643	6	29·6758	7	29·6593	7	29·5485
August 6 to September 1 ..	7	29·7471	7	29·9114	7	29·4707	6	29·9083
September 2–29	7	29·5743	7	30·1450	7	29·8107	7	29·8071
September 30 to October 26	6	30·3225	7	29·9721	7	29·4271	7	29·7535
October 27 to November 22	7	29·2678	6	29·1391	7	29·8557	7	29·5221
November 23 to Dec. 20 ..	7	29·1985	6	29·3266	8	30·2018	7	30·1907
362 days.	88	29·5696	85	29·7061	96	29·7283	93	29·6866

Barometrical Averages, &c.

Year and Periods.	Days.	Coming N.	Days.	North.	Days.	Going S.	Days.	South.
		in.		in.		in.		in.
Dec. 21, 1838 to Jan. 16, 1839	7	29·6593	6	30·0075	7	29·3828	7	29·8335
January 17 to February 12..	6	29·7066	7	30·0500	7	29·7338	7	30·1707
February 13 to March 12 ..	7	29·5764	7	29·7157	7	30·0678	7	29·9528
March 13 to April 8	6	29·6983	7	29·5778	7	29·5364	7	30·1393
April 9 to May 6	7	30·3028	6	29·6591	7	30·0828	8	29·8706
May 7 to June 2	6	30·0133	7	29·7085	6	30·0375	8	30·0875
June 3–29	6	29·7108	7	29·9914	7	29·7457	7	29·6343
June 30 to July 26	6	30·0841	7	29·5835	7	29·6671	7	29·6221
July 27 to August 22.....	7	29·6443	6	29·9141	7	29·8235	7	29·9007
August 23 to September 19 .	7	29·7293	7	29·2593	7	29·6635	7	29·1814
September 20 to October 16 .	6	29·5291	7	29·6064	7	29·8650	7	29·7078
October 17 to November 13 .	7	29·9271	6	30·3333	7	29·8193	8	29·5800
November 14 to December 10	6	29·7666	6	29·7033	8	29·4881	7	29·9250
December 11–23	7	29·3928	6	29·1758				
368 days.	91	29·7672	92	29·7347	91	29·7626	94	29·8158
Dec. 24, 1839 to Jan. 6, 1840	..	....	..	....	7	29·6443	7	29·8007
Jan. 7 to Feb. 2.....	7	30·1457	6	29·5441	7	29·1057	7	29·3843
February 3 to March 1	7	29·2600	6	29·6741	7	30·2893	8	30·4575
March 2–28	6	30·5041	6	30·3100	8	30·1956	7	30·1607
March 29 to April 24.....	7	29·8300	6	29·9783	7	30·0000	7	30·1857
April 25 to May 22	7	30·2485	6	29·9866	7	29·5728	8	29·8018
May 23 to June 18.....	7	29·8378	6	29·9566	6	29·8183	8	29·6793
June 19 to July 15.....	7	29·7450	6	29·8216	7	29·4428	7	29·9164
July 16 to August 11.....	7	29·5493	6	29·7825	7	30·0328	7	29·8500
August 12 to September 8..	7	29·3700	7	29·7614	6	29·9975	8	29·7575
September 9 to October 5 ..	6	29·5616	7	29·5057	7	29·5185	7	29·9457
October 6 to November 1 ..	7	30·2550	6	29·8550	7	29·7407	7	29·2628
November 2–29	7	28·8143	6	29·7575	7	29·4371	8	30·1068
November 30 to December 19	7	30·0857	6	29·7833	7	30·0185		
362 days.	89	29·7851	80	29·7474	97	29·7724	96	29·8699

Barometrical Averages, &c.

Year and Periods.	Days.	Coming N.	Days.	North.	Days.	Going S.	Days.	South.
		in.		in.		in.		in.
December 20–26, 1840	..	. ..	..	....	..	....	7	30·2678
Dec. 27, 1840 to Jan. 22, 1841	7	30·0185	6	29·4708	7	29·3257	7	29·8750
January 23 to February 18 .	8	30·0085	6	30·1100	7	29·7057	7	29·3535
February 19 to March 18 ..	7	30·0443	6	29·5758	6	30·0541	8	29·8550
March 19 to April 14	7	29·5207	6	29·5158	7	29·4850	7	29·7793
April 15 to May 11	7	29·7350	6	29·6400	7	29·7907	7	29·6650
May 12 to June 8	7	29·7293	7	29·7757	6	29·9175	8	30·0050
June 9 to July 5	7	29·8428	6	29·6700	7	29·6671	7	29·8614
July 6 to August 1	7	29·5471	6	29·6833	7	29·7371	7	29·6093
August 2–28	7	29·5057	7	29·5414	6	29·8050	7	29·9543
August 29 to September 25 .	8	29·6656	6	29·7008	7	29·7850	7	29·6114
September 26 to October 22	7	29·2443	6	29·0675	7	29·4378	7	29·5014
October 23 to November 18	7	29·3571	7	30·0778	6	29·9675	7	29·2857
November 19 to December 15	8	29·4881	6	29·0433	7	29·3657	6	29·3708
December 16–23	8	29·3762						
369 days.	102	29·6488	81	29·6055	87	29·6957	99	29·7139

END OF PART II.

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